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GEOLOGICAL EXCURSIONS
ROUND
THE ISLE OF WIGHT,
AND ALONG THE
ADJACENT COAST OF DORSETSHIRE.

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GEOLOGICAL EXCURSIONS

ROUND

THE ISLE OF WIGHT,

AND ALONG THE

ADJACENT COAST OF DORSETSHIRE;

ILLUSTRATIVE OF THE MOST

INTERESTING GEOLOGICAL PHENOMENA AND ORGANIC REMAINS.

BY

GIDEON ALGERNON MANTELL, ESQ. LL.D. F.R.S. F.G.S.

AUTHOR OF "THE WONDERS OF GEOLOGY;" "THE MEDALS OF CREATION;"
"THOUGHTS ON A PEBBLE;" ETC

FOSSIL LOBSTER FROM ATHERFIELD.

> "That beautiful Island, which he who once sees never forgets, through whatever part of the wide world his future path may lead him."
>
> SIR WALTER SCOTT'S *Surgeon's Daughter*.

THIRD EDITION.

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TO

HIS ROYAL HIGHNESS

PRINCE ALBERT,

AS A TESTIMONY OF ADMIRATION AND RESPECT

FOR HIS ROYAL HIGHNESS'S

LIBERAL ENCOURAGEMENT OF BRITISH SCIENCE AND ART,

AND ARDENT SUPPORT OF EVERY ATTEMPT

TO AMELIORATE THE CONDITION AND PROMOTE THE HAPPINESS

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HUMBLE AND DEVOTED SERVANT,

GIDEON ALGERNON MANTELL.

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PREFATORY NOTE TO THE THIRD EDITION.

In the "Supplementary Chapter," appended to the last edition of this work, the author—whose loss the scientific world and his many friends deplore—supplied to his readers a notice of such fossils and geological facts as had accrued during the four previous years. This valuable *resumé* of the more recent discoveries in the Tertiary, Cretaceous, and Wealden deposits has been retained intact in the present edition; but that the reader may be in possession of the latest discoveries, a succinct account of the further progress of geological research has been drawn up by a scientific friend of the much lamented deceased, to whom, also, have been entrusted those sheets of the new edition of the "Medals" which Dr. Mantell left imperfectly revised.

Since the publication of the second edition, the progress of observation has enriched us with many facts concerning the geological history of those southern parts of England, to a notice of which the present volume is devoted; and the many geologists, amateur and professional, who have visited the coasts of Hants, Dorset, and the Isle of Wight, have added numerous valuable fossils to our public and private museums. Some of these have been already described and figured, but a large proportion still remain unknown to the reading public.

Before proceeding to speak more especially of the Isle of Wight and the neighbouring coasts, it should be noticed that by laborious research over both old and new ground, and by careful examination of collected specimens, much light has been thrown on the geological structure of districts hitherto obscure; greater precision has been arrived at in the chronological arrangement of various deposits, and further insight obtained into the pre-adamitic history of the animal and vegetable kingdoms. Of these additions to our knowledge, the journals of the geological societies of London, Dublin, Paris, Berlin, and Vienna are the chief repositories. We shall here refer only to some of the most interesting of the facts that have thrown new light on the science of geology.

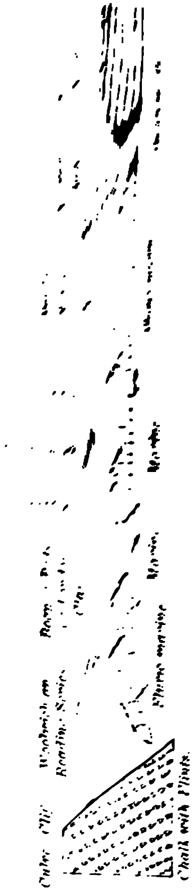
The discovery of traces of large limuloid crustaceans, in the lowest Silurian or Cambrian rocks of Canada and the United States; of fresh-water shells (*anodons*) in the Devonian rocks of the South of Ireland; of tracks and remains of at least two kinds of reptiles in the "old red" of Morayshire; the traces of others in the lower carboniferous or Devonian of Pennsylvania; of reptilian remains in the coal of Scotland and of Nova Scotia; and of land-shells, with the reptiles in the upright tree-stumps, in the latter; of small mammalia in the trias of Wurtemberg; of numerous groups of gasteropoda in the cretaceous rocks of Europe; and of a great variety of dicotyledonous leaves in the lower cretaceous deposits of Aix la Chapelle and elsewhere,—are great facts, illustrative of many an obscure passage in the [illegible] our earth. The noble work devoted to the Palæontology of Bohemia, the ample and highly illustrated volumes of American research, the "Palæontographical Monographs," the "*Paléontologie Française*," the Cambridge "*Fasciculi*," and the Survey "*Decades*" are some of the latest of the great works to which geologists may now turn for the history and portraiture of bygone forms.

Leaving the general consideration of the late acquisitions to our knowledge of ancient faunas and floras, and of the history of their entombment, to the works which especially treat of these subjects, we necessarily limit our observations to those points of interest which are connected with the geology of the Isle of Wight.

I.—CLASSIFICATION OF THE TERTIARY STRATA. (See tabular arrangement, p. 43, and supplemental note, p. 305.)

We have first to notice the important modification which Professor E. Forbes has found necessary to introduce into the classification of the eocene deposits of the northern part of the island. A strict investigation of the distribution and organic contents of the fluvio-marine tertiaries of the Isle of Wight was recently undertaken by this eminent palæontologist; and a general view of the results arrived at will be found in the "Quarterly Journal of the Geological Society," No. 36 (November, 1853).

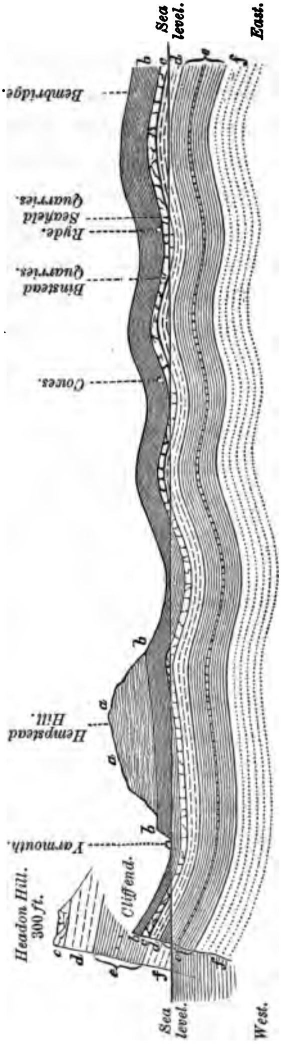
The greater part of the Isle of Wight, north of the great chalk ridge, has been hitherto regarded as composed of eocene beds of freshwater and estuary origin, and of the age of those composing Headon Hill. Professor E. Forbes, however, finds that, contrary to received views, almost all the surface of the island north of the chalk hills is composed of strata higher in the series than



Lign. 44. [illegible]

the Headon beds, and intermediate between these and the beds of Hempstead Hill; that all the formations, except those of Headon Hill itself, belong to the system of these higher strata; that there are two systems of rolls, or undulations, of these beds and of all the tertiaries, one parallel to, and the other at right angles with, the strike of the chalk ridge; that both these undulations affect the chalk itself; that the northern part of Whitecliff Bay (see lign. 44), in the fluvio-marine portion of its beds, does not represent Headon Hill, as has hitherto been maintained, but includes some 200 feet of higher beds; and that over and above the Headon series (lign. 45), there are three sets of beds characterised by peculiar fossils.

At the same time, although there is ample evidence to show that the two upper of these series are the equivalents of the lower miocene of foreign authors, there is also good proof that they all belong to



a, *Hempstead Series.* *c*, *Bembridge limestone.* *e*, *Headon fluvio-marine Series.*
b, *Bembridge Marls.* *d*, *St. Helen's Beds.* *f*, *Headon Sands.*
(See "Quart. Journ. Geol. Soc." No. 36, p. 260.)

LIGN. 45.—DIAGRAM.—SECTION OF THE UPPER EOCENE TERTIARIES OF THE ISLE OF WIGHT.

the eocene system. Professor E. Forbes proposes the following classification for the fluvio-marine eocene tertiaries of the borders of the Solent:

1. The Hempstead series, 170 feet thick, composed of marls and clays, the uppermost of which are marine. This division, of small superficial extent, is the equivalent of the Limburg beds of Belgium, and, in part, of the Mayence basin, and of the Grès de Fontainebleau. To the level of the middle and lower portions of this series, the so-called miocenes of Malta, and equivalent beds in Barbary, Greece, Italy, Spain, Portugal, and France may now with probability be referred. The distinctness of the vertebrate re-

mains contained in these beds, from those of Binstead and Hordwell, was several years ago indicated by the Marchioness of Hastings. 2. The Bembridge series, about 110 feet thick, consisting of estuary marls, marine beds, and freshwater limestones (those of Bembridge, Sconce, Binstead, &c.), abounding in peculiar fossils, and forming almost the whole of the north shore of the Isle of Wight. This group is the equivalent of the gypsiferous series of the Paris basin. 3. The St. Helen's beds, from 60 to 100 feet thick, variously composed, of estuary and freshwater origin, becoming in part good stone, to the east of Ryde. These beds, possibly representing in part the Grès de Beauchamp, separate the Bembridge from—4. the Headon series, 170 feet or more of strata, forming three divisions long known as the upper freshwater, inter-marine, and lower freshwater. The Hordwell fluvio-marine beds belong to a part of this division.

Mr. Prestwich's continued researches in the structure of the tertiary deposits of the London and Hampshire series have further elucidated the complicated relations of these clays, sands, and ancient gravel beds. The corrected classification of the eocene strata effected by this talented and indefatigable geologist, and the improved nomenclature by which the series is now known, are given in the following table of the superficial and tertiary deposits :—

TABLE OF THE TERTIARY DEPOSITS OF ENGLAND.

PLEISTOCENE:					
	Alluvial; or recent river and estuary deposits	Plumstead Marshes, Lewes Levels, &c.			
	Ancient river and estuary deposits	Brick-earth at Erith, Grays, Gaytonthorpe, &c.; Hyde Park Gravel, &c.			
	Northern drift; or erratics	The Boulder-clay, and its sands and gravels.			
PLIOCENE					
	Bridlington crag, of the Yorkshire coast.				
	Red and coralline crags of Norfolk and Suffolk.				
EOCENE.					
Upper.	Hempstead Series Bembridge Series	(See pp. ix.—xii., and ligns. 44 and 45.)			
Middle.	St. Helen's Beds				
	Headon Series	The richly fossiliferous deposit, of fluvio-marine origin, at *Hordwell* (see p. 121, and supplementary chapter) belongs to this series.			
	Upper Bagshot Series	The well-known *Barton Cliff* (see pp. 120, 124), near Christchurch, exhibits a local argillaceous condition of this part of the series	The white clays and sands near *Corfe* represent these deposits in their extension to the westward	Middle & Upper.	London Tertiaries.
	Middle ditto	This division is greatly developed and highly fossiliferous at *Bracklesham Bay*.			
	Lower ditto	A notice of this group, as it occurs in Surrey, is given at page 59.			
Lower.	London Clay	The *Bognor Rock* is a subordinate member of this division			
	Basement-bed of the London clay	(See supplementary chapter, p. 305, *et seq.*)		Lower.	
	Woolwich and Reading Series	Formerly known as the "mottled clays," and "plastic clay"			
	Thanet Sands	(See Mr. Prestwich's Memoir on this lowest tertiary group, "Geol. Soc. Journal," 1852, vol. viii., pp. 285, *et seq.*)			

II. Superficial Deposits.

Some years since, Mr. Bowerbank noticed the existence of a superficial calcareous bed, containing land-shells of existing species, on the chalk of St. Catherine's Down, and seen in the face of Gore cliff. This deposit, which at first sight might be mistaken for the top of the chalk itself, is a terrestrial or subaërial formation, consisting of the surface-debris, or "run of the hill," on the slope of the chalk-down which once existed, but has been long ago cut away by the sea, and replaced by the present cliff. Similar deposits are common in the Isle of Wight and along the sides of the chalk-hills of Kent and Sussex; and Mr. Trimmer and Professor E. Forbes have lately described another such occurrence at Tolland's Bay. Here, however, local modifications are indicated by the presence of vegetable matter and fresh-water shells, as well as land-shells, in these marly beds.

In making a road for the conveyance of stone for the construction of the Breakwater at Portland in 1851, the fissures in the rock were found to be occupied by a deposit differing from the superficial soils, and containing large rounded boulders, sand, and bones and teeth of the horse, elephant, deer, and other animals. Bones of the wild boar had previously been found in Portland.

III. Tertiary Fossils.

Between Corfe and Wareham, in Dorsetshire, some of the white clay and sandy marls of the pipe-clay pits have been found by Mr. Charles Groves, of the latter town, to be full of dicotyledonous leaves. A portion of the leaf of *Palmacites Lamanonis* has been obtained from these beds by Mr. Grov [illegible] ves generally are like those of

Alum Bay and Bournemouth. The laminated white clays at Poole Head also abundantly yield similar relics of this ancient flora.

Mr. W. R. Brodie, who has made a fine collection of leaves from the Corfe clays, has also discovered several specimens of insect remains, consisting of coleopterous wing-cases.* These plastic clays belong to the Bagshot series.

In the still older clays of the Reading series, formerly known as the "Plastic Clay," Mr. Prestwich has lately found numerous dicotyledonous leaves, stems, &c. These occurred in limited patches of clay near Reading, and possess a general resemblance to the eocene flora of some parts of Europe, but they have not yet been critically examined.

The eocene corals have been described and figured by MM. Milne Edwards and J. Haime ("Palæontographical Monographs"); few, however, occur at Barton and Bracklesham. The Bryozoa—a more numerous class of coralliform animals, existing under somewhat similar conditions, but essentially different from the corals, and of much higher organisation—are for the most part still unworked. In Dixon's "Geology and Fossils of the Tertiary and Cretaceous Formations of Sussex,"† some of the latter, as well as some corals, are illustrated and described. Mr. Dixon's

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* "Quart. Journal Geol. Soc." vol ix. p. 53.

† Quarto, 1850. This valuable work, so indispensable to the geologist who is occupied with the study of the eocene and chalk deposits, deserves more than a passing notice. It demands attention by the artistic skill and care expended on the numerous and beautiful illustrations, the work of Sowerby, Dinkel, and Erxleben; on account of the elaborate palæontological details,—the combined result of the scientific labours of Owen, Egerton, Bell, Lonsdale, Forbes, and Sowerby; and on account of the interesting and learned introductory chapters, containing geological and archæological notices of

Of the mollusca of the tertiary deposits of these districts, Mr. Edwards, Mr. Prestwich, and others have published in their respective memoirs good figures and descriptions; but to the late Mr. Dixon's work, already noticed, we must refer for a large mass of information on this subject, and on the icthyology of the tertiary period; several remains of the larger animals are also figured by Mr. Dixon, but the monographs on the fossil reptiles, by Professor Owen and Professor Bell, afford a compendious history and elaborate illustrations of these most important relics. We must not omit, however, to refer the reader to the beautiful coloured plate of the skull of the Hordwell alligator, in "Charlesworth's Geological Journal."

The eocene tertiaries of England abound with remains of turtles, both of the marine and the freshwater groups of these animals.

"The majority of the eocene chelonites," says Professor Owen,* "belong to the true marine genus *chelone;* and the number of species of these extinct turtles already obtained from so limited a space as the Isle of Sheppy† exceeds that of the species of *chelone* now known to exist throughout the globe."‡

In the "Palæontographical Monograph," 1850, p. 49, after describing the crocodiles of the "London clay proper," from Sheppy and Harwich, Professor Owen proceeds to give, in detail, the structure of the *Crocodilus Hastingsiæ* and *Alligator Hantoniensis*, of Hordwell, and the *Gavialis Dixoni*, of Bracklesham; and, in reviewing the interesting palæontological facts to the elucidation of which his labours have so greatly contributed, the Professor eloquently remarks :—

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* "Monograph on the Eocene Reptiles," 1849, p. 44.

† Seven species from Sheppy, two others from Harwich, and two or three from the Hampshire tertiaries, are described by Professors Owen and Bell.

‡ "All the tropical seas of the world have hitherto yielded no more than five well defined species of *chelone;* and of these only two, as the *Ch. mydas* and *Ch. caouana,* are known to frequent the same locality."—*Ibid.*, p. 44.

"Crocodiles, gavials, and alligators now require, in order to put forth in full vigour the powers of their cold-blooded constitution, the stimulus of a large amount of solar heat, with ample verge of watery space, for the evolutions which they practise in the capture and disposal of their prey. Marshes with lakes, extensive estuaries, large rivers, such as the Gambia and Niger that traverse the pestilential tracts of Africa, or those that inundate the country through which they run, either periodically, as the Nile for example, or with less regularity, like the Ganges; or which bear a broader current of tepid water along boundless forests and savannahs, like those ploughed in ever-varying channels by the force of the mighty Amazon or Oronooko,—such form the theatres of the destructive existence of the carnivorous and predacious crocodilian reptiles. And what, then, must have been the extent and configuration of the eocene continent which was drained by the rivers that deposited the masses of clay and sand, accumulated in some parts of the London and Hampshire basins to the height of one thousand feet, and forming the graveyard of countless crocodiles and gavials? Whither trended that great stream, once the haunt of alligators, and the resort of tapir-like quadrupeds, the sandy bed of which is now exposed on the upheaved face of Hordwell Cliff?

"Had any of the human kind existed and traversed the land where now the base of Britain rises from the ocean, he might have witnessed the gavial cleaving the waters of its native river with the velocity of an arrow, and ever and anon rearing its long and slender snout above the waves, and making the banks re-echo with the loud and sharp snappings of its formidably armed jaws. He might have watched the deadly struggle between the crocodile and palæothere, and have been himself warned by the hoarse and deep bellowings of the alligator from the dangerous vicinity of its retreat. Our fossil evidences supply us with ample materials for this most strange picture of the animal life of ancient Britain; and what adds to the singularity and interest of the restored *tableau vivant*, is the fact that it could not now be presented in any part of the world. The same forms of crocodilian reptile, it is true, still exist, but the habitats of the gavial and the alligator are wide asunder, thousands of miles of land and ocean intervening; one is peculiar to the tropical rivers of continental Asia, the other is restricted to the warmer latitudes of North and South America; both forms are excluded from Africa, in the rivers of which continent true crocodiles alone are found. Not one representative of the crocodilian order naturally exists in any part of Europe; yet every form of the order once flourished, in close proximity to each other, in a territory which now forms part of England."

IV.—Fossils of the Chalk.

To the palæontological history of the chalk, and its associated galt and greensands of the south-east of England, Sir P. Egerton and Professor Owen have added valuable descriptions and figures of reptiles and fishes; whilst Professor E. Forbes has described a large mass of of the echinoderms; Mr. Sowerby and others, numerous mollusca; Professor Bell, the larger crustacea; Mr. Lonsdale, the corals; Mr. Davidson, the terebratulæ; Mr. Morris, the clionites; Mr. Rupert Jones, the minute entomostraca; and Mr. John Brown has lately figured some of the foraminifera.

V.—Wealden Fossils.

The Wealden and Purbeck deposits have considerably enriched the collectors who have devoted time and labour to the search for fossils. The novel and gigantic reptile, the pelorosaurus, was first known from the relics found by Mr. Fuller, near Cuckfield, and described by Dr. Mantell, "Phil. Trans." 1850. Mr. Beckles has continued his examination of the Wealden of Hastings and the vicinity; and, besides some remains of the iguanodon, has found and carefully worked out from the rock, at low water, the magnificent *humerus*, *ulna*, and *radius* of the pelorosaurus which were described by Dr. Mantell, in 1852, at the Royal Institution (March 5). Mr. Beckles has also added to his Wealden collection numerous fine fish remains, especially perfect heads and dorsal rays, together with splendid fronds of cycads and ferns, numerous uniones, and other fossils.

The Purbeck marls and limestones had already yielded the remains of a host of insects; but the Wealden proper (which overlies the Purbecks) had, with the exception of one wing (found by Professor E. Forbes in the Hastings series of the Isle of Wight), given no indication of the insect-life of that period.

We have now, however, the pleasure of recording that Messrs. W. R. and H. Binfield, to whose successful search for insect remains in the lias of Gloucestershire and Dorset their cabinets bear ample testimony, have developed from the Wealden strata, at Hastings, St. Leonard's, and in the neighbourhood, numerous specimens of wings and wing-cases of various species of insects. This important addition to our knowledge of the fauna of the Wealden proper was lately worked out by these gentlemen during a short recess from professional labours, and indicates a fine field of research for such as have the requisite eye, tact, and patience for the finding of insect remains.

VI.—Purbeck Fossils.

From the Purbeck formation, on the Lulworth coast, Mr. C. Groves, of Wareham, has lately obtained a large portion of the lower jaw of the "Swanage crocodile," (*Goniopholis crassidens*,) see p. 258. It was imbedded in the marls not far above the "cinder bed." Figures and descriptions of some of the fishes of the Purbeck have been given to the scientific world by Sir Philip Egerton.

VII.—Oolite Fossils.

A few bones of crocodilian reptiles have been found by Mr. Neale and others in the Portland oolite, at Portland; a single coleopterous wing-case has been detected by the Rev. Mr. Brodie's practised eye in the Kimmeridge clay of Ringstead Bay;[*] some new fishes have been found in the black shales at Kimmeridge, together with a fine *sepia* and other interesting fossils, by Mr. Grove, of Wareham; and, lastly, a magnificent paddle of a very large *pleiosaurus*, from the Kimmeridge clay of the Isle of Purbeck, has been deposited in the Dorchester Museum.

Thus have surveyor and collector, geologist and palæontologist, each contributed during the few past years the results of their untiring labours to the building up of the yet imperfect temple of science. The solid frame-work and the delicate adornment have equally advanced under the care of the naturalists devoted to the study of geological phenomena; whether working out the history of a mountain-range, or noting the structure of a sand-bank; whether exhuming mighty bones, or studying the almost invisible relic of the animalcule. These later additions to our knowledge still confirm the philosophical generalisations so clearly laid down in the "Retrospective Summary,"

[*] "Quart. Journ. Geol. Soc.," vol. ix., p. 51.

at page 334, and in the body of the work, at page 293; they enable us to add many an organic form to our lists of the extinct faunas and floras of ancient lands and seas, and sometimes add antiquity to the genealogical descent of a species, a genus, or a family; yet they offer no contradiction to the general statements with regard to the history of the globe and its inhabitants, so lucidly and eloquently treated by the lamented author of the "GEOLOGY OF THE ISLE OF WIGHT."

T. R. J.

PREFACE.

THE ISLE OF WIGHT is described by Sir Walter Scott, as "that beautiful Island, which he who once sees never forgets, through whatever part of the wide world his future path may lead him." And if this favoured spot deserve such an encomium from the Poet, and the ardent admirer of beautiful and picturesque scenery, it possesses stronger claims to the attention of the natural philosopher, for the strata of which it is composed present phenomena of the highest interest, and abound in those "Medals of Creation," which elucidate some of the most important revolutions recorded in the early pages of the earth's physical history.

The geological characters of the Isle of Wight are well known to the scientific inquirer through the labours and publications of Sir HENRY ENGLEFIELD, Mr. THOMAS WEBSTER, and other able observers; while the beautiful models of the stratification of the Undercliff, and southern coast, constructed by Captain IBBETSON, and the collection of fossils accompanying them, which are exhibited in the Polytechnic Institution of London, afford an instructive exposition of the strata and organic remains of this interesting district.

But notwithstanding these admirable illustrations, I may venture to affirm, that the Geology of the Island is but little known or regarded by the majority of the intelligent persons who every season flock by thousands to its shores, and, rapidly traversing the accustomed routes, visit the picturesque localities noted in the numerous hand-books, and take their departure, without suspecting that they have been travelling over a country rich with the spoils of nature, and teeming with objects of the highest interest to the instructed observer.

Even the inhabitants, with but a few honourable exceptions, manifest an extraordinary degree of apathy in everything relating to the Geology of the Island. In vain will the stranger seek for public collections illustrative of its physical structure and fossil remains. In one week it would be easy for a practical geologist to collect a more instructive series of specimens than is contained in the Museum of the Scientific Institution of the capital of the Island—Newport.

Conceiving that this indifference and neglect may, in a great measure, be attributable to the want of a popular guide to the geological phenomena of the Island, for the well informed but unscientific visitors, I have attempted to supply the deficiency in the present volume; which is designed to afford a familiar explanation of the physical structure of the Isle of Wight and the adjacent coast of Dorsetshire, and of the organic remains which abound in many of the localities that will come under our notice in the course of these Excursions.

For the convenience of the geologist, and of others who may be desirous of investigating the stratification of the Island in detail, a list is subjoined of the principal works and memoirs hitherto published on the subject, and of which a general review is comprised in the following pages.

January, 1847.

ADVERTISEMENT TO THE SECOND EDITION.

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Although no effectual steps have yet been taken to establish in the Isle of Wight a public collection of its natural productions, yet so many interesting fossils from various parts of the Island have been discovered and submitted to my examination since the publication of the former edition of this volume, that I have reason to conclude my humble attempts to direct attention to the geological phenomena of the district have not been wholly fruitless.

From the want of a local Museum, numerous valuable specimens have, however, been dispersed, and are now irretrievably lost to science; yet the facts described in the Supplementary Chapter are sufficient proofs of the important acquisitions relating to the ancient physical history of the globe, that may be gathered by individual research, and of the facility with which an extensive collection illustrative of the Geology and Palæontology of the Island might be made, if but few of the intelligent and wealthy inhabitants would combine to effect so desirable an object.

That the illustrious Prince, who so zealously encourages every attempt to promote the advancement of Art and Science, would extend his patronage to such an Institution there can be no doubt; and I still indulge the hope that the "Beautiful Island" will possess ere long, in a well-arranged Museum of its natural productions, a new and powerful attraction to visitors and tourists, and an inexhaustible source of intellectual gratification to the inhabitants.

G. A. M.

December, 1850.

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"If we look with wonder upon the great remains of human works, such as the columns of Palmyra, broken in the midst of the desert; the temples of Pæstum, beautiful in the decay of twenty centuries; or the mutilated fragments of Greek sculpture in the Acropolis of Athens, or in our own museums, as proofs of the genius of artists, and power and riches of nations now passed away; with how much deeper feeling of admiration must we consider those grand monuments of nature which mark the revolutions of the globe; continents broken into islands; one land produced, another destroyed; the bottom of the ocean become a fertile soil; whole races of animals extinct, and the bones and exuviæ of one class covered with the remains of another, and upon the graves of past generations—the marble or rocky tomb, as it were, of a former animated world—new generations rising, and order and harmony established, and a system of life and beauty produced out of chaos and death; proving the infinite power, wisdom, and goodness of the GREAT CAUSE of all things!"

SIR H. DAVY.

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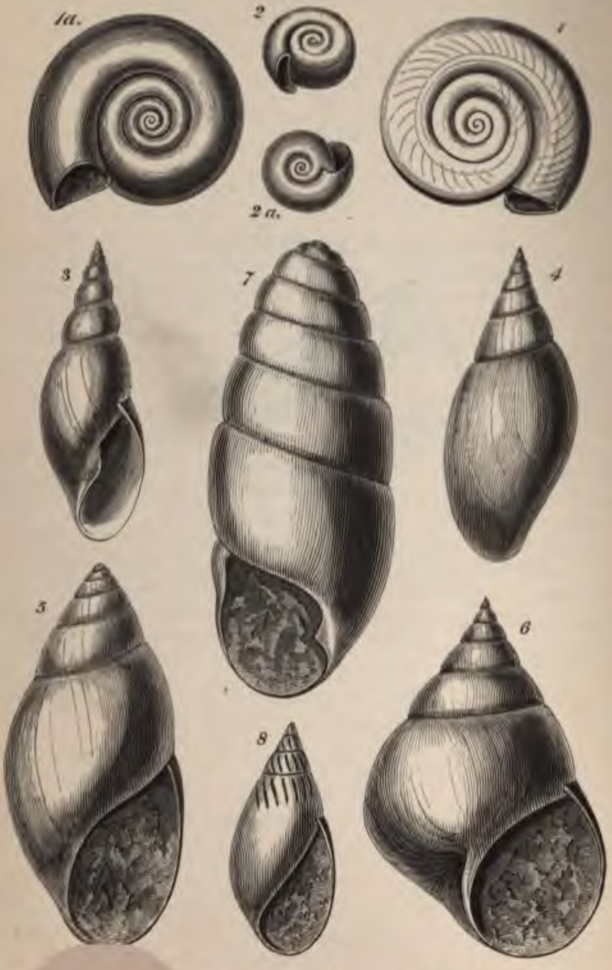
Pl. I.



ROM THE FRESH-WATER EOCENE STRATA OF THE ISLE OF WIGHT.

DESCRIPTION OF PLATE I.

FOSSIL SHELLS FROM THE FRESH-WATER EOCENE DEPOSITS.

Fig. 1^a.—*Planorbis euomphalus*; the underside.
1.—The same shell on the upper side; from Calbourne.
2.—*Planorbis cylindricus*; Calbourne.
2^a.—*Planorbis obtusus*; Shalfleet.
3.—*Limneus longiscatus*; Binstead.
4.—*Limneus fusiformis*; Headon Hill.
5.—*Limneus maximus*; Calbourne.
6.—*Paludina angulosa*; Calbourne.
7.—*Bulimus ellipticus*; Binstead.
8.—*Bulimus costellatus*; Shalfleet.

These fossil shells occur in the limestone and marls at Headon Hill, and in the quarries at Dodspits, Shalfleet, Calbourne, and Binstead, near Ryde. The *Planorbis* and *Limneus* are the most abundant genera; and casts of the common species may be seen in profusion in the cream-coloured limestones used in the walls of cottages, barns, &c., in the northern parts of the Island.

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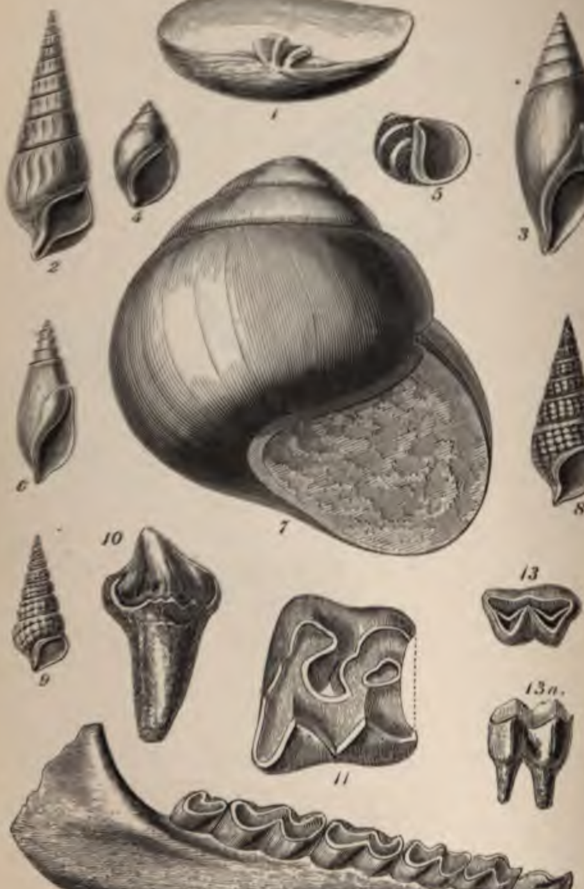
Pl. II.



SSIL SHELLS AND MAMMALIAN REMAINS, FROM THE FRESH-WATER STRATA OF THE ISLE OF WIGHT.

DESCRIPTION OF PLATE II.

FOSSIL SHELLS AND TEETH OF MAMMALIA, FROM THE FRESH-WATER EOCENE DEPOSITS.

SHELLS.

Fig. 1.—*Potomomya gregaria*; from Headon Hill.

This shell is described by Mr. Sowerby in Mineral Conchology as Mya gregaria. The genus *Potomomya*, (river mussels), comprises those species which inhabit rivers only, and are not found in estuaries and brackish waters.

2.—*Potamides concavus*; Headon Hill.
3.—*Melanopsis fusiformis*; Headon Hill.
4.————— *brevis*; Headon Hill.
5.—*Neritina concava*; Colwell Bay.
6.—*Melanopsis carinata*; Colwell Bay.
7.—*Helix globosus*; Shalfleet.
8.—*Potamides plicatus*; Headon Hill.
9.————— *ventricosus*; Headon Hill.

MAMMALIAN REMAINS.

10.—Upper canine tooth of *Anoplotherium commune*; from Seafield, near Ryde.
11.—The grinding surface of an *upper molar*, of *Palæotherium medium*; from Binstead.
12.—One side of the lower jaw of *Palæotherium minus*, with five teeth; from Seafield.[*]
13^{a}.—A tooth of *Dichobune cervinum*, from Binstead.
13.—The grinding surface of fig. 13^{a}.

With the exception of the gigantic snail-shell, fig. 7, the fossil shells here delineated are abundant at Headon Hill, and in the clays and marls at Colwell Bay. The Mammalian remains are of excessive rarity, and have hitherto only been found in the quarries near Ryde, and at Headon Hill.

[*] See "British Fossil Mammals," p. 323.

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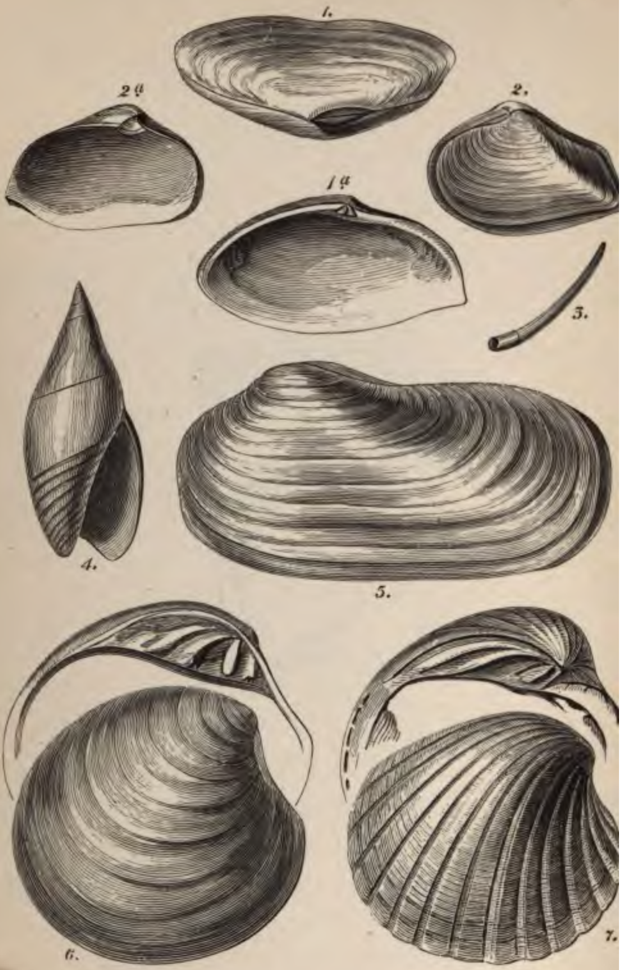
Pl. III.



OSSIL SHELLS FROM THE MARINE EOCENE STRATA OF THE ISLE OF WIGHT.

DESCRIPTION OF PLATE III.

FOSSIL SHELLS FROM THE MARINE EOCENE DEPOSITS.

Fig. 1.—***Psammobia solida***, the valves united; from Headon Hill.

1ª·—The inner aspect of one of the shells of the same.

2.—***Corbula cuspidata***, the united valves. White Cliff Bay.

2ª·—The inner aspect of one of the shells of the same species.

3.—***Ditrupa plana***; Alum Bay.

This ***pteropodous mollusk*** is abundant in the sandstone rock, that overlies the mottled clays which intervene between the chalk and the upper eocene deposits.

4.—***Ancillaria subulata***; Alum Bay.

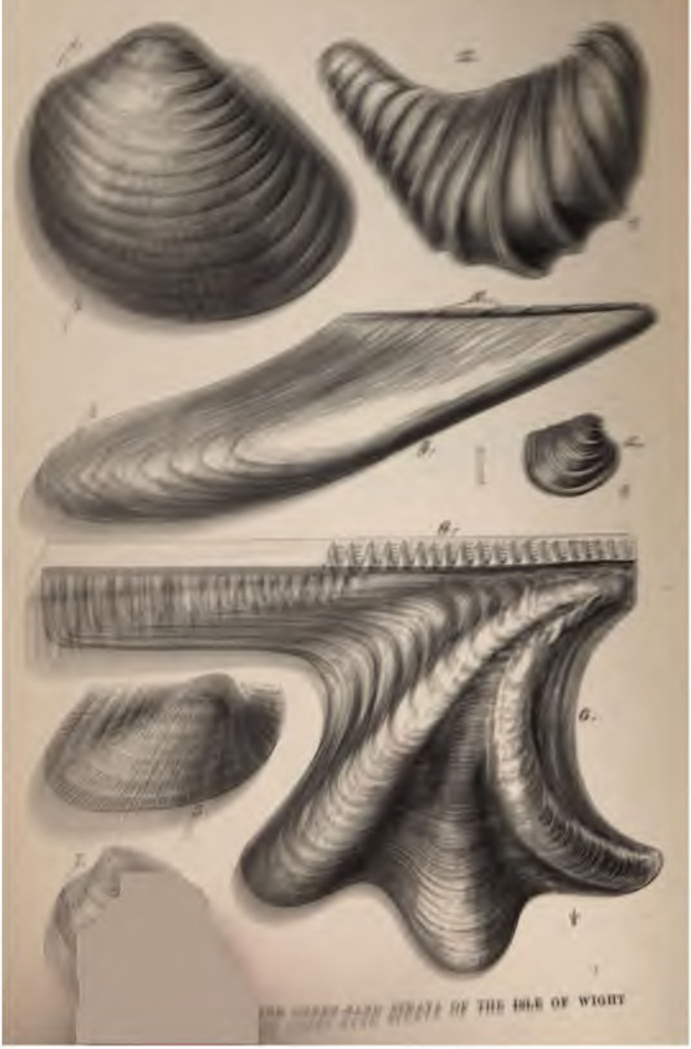
5.—***Panopæa intermedia***; Alum Bay.

6.—***Cytherea incrassata***; Colwell Bay.

7.—***Cardita planicosta***, half the natural size; Alum Bay.

These shells are abundant in most of the localities of the marine tertiary clays, both in the Island, and on the opposite coast of Hampshire and Sussex. The *Panopæa intermedia* (fig. 5), is a well-known shell in the Bognor Rocks; and the *Cardita planicosta* (fig. 7), occurs in profusion in the clay at Bracklesham Bay, in Sussex. The *Cytherea incrassata* (fig. 6), is found in a sandy clay at Colwell Bay, almost as perfect and fresh as if recently left by the sea.

PL. LXV.



LOWER GREEN SAND STRATA OF THE ISLE OF WIGHT

DESCRIPTION OF PLATE IV.

FOSSIL SHELLS FROM THE LOWER GREEN-SAND DEPOSITS.

Fig. 1.—*Corbis corrugata*, from the sand-rock, Atherfield: the figure is one-half the size in linear dimensions of the original.

2.—*Trigonia caudata;* from the sand-rock, Atherfield.

3.—*Gervillia anceps;* from the Cracker Rocks, Atherfield. ***a***, denotes the markings of the hinge, which are seen in consequence of the valves being slightly displaced. It is represented half the size linear, of the original. These shells are often much larger, and more elongated than in the figure.

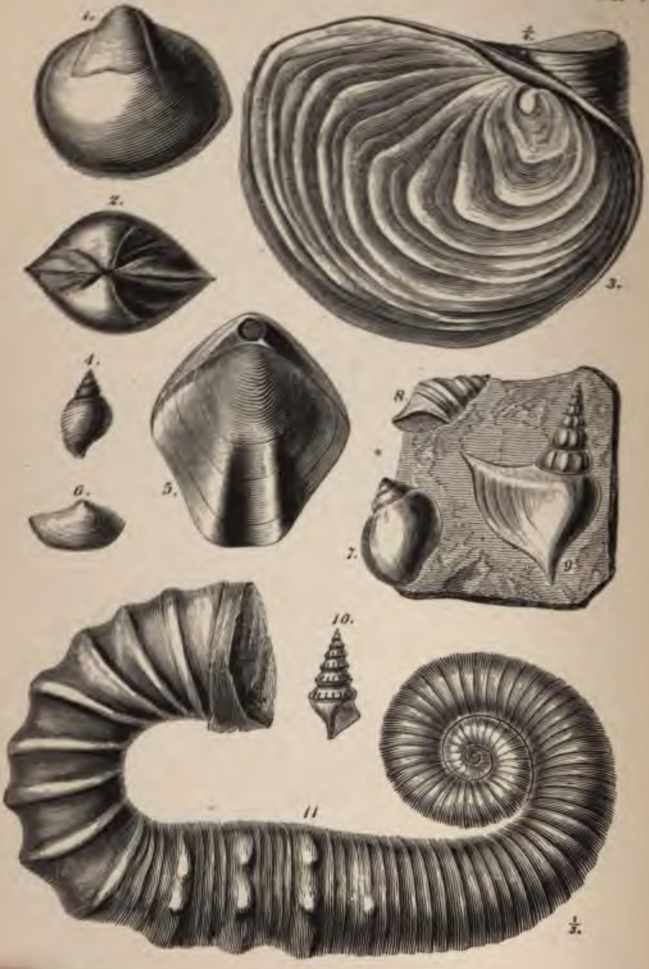
4.—*Venus striato-costata;* a small shell, common in the Cracker Rocks at Atherfield; the figure is twice the size of the original in linear dimensions.

5.—*Arca Raulini;* from the sand-rock, Atherfield.

6.—*Perna Mulleti;* from the lower beds of sand in junction with the Wealden; Sandown Bay. The figure is but half the size of the original. ***a***, the structure of the hinge; by comparing this figure with ***a***, figure 3, the difference of the hinge in the genera *Perna* and *Gervillia* will be recognised. This large and remarkable shell is highly characteristic of the lower beds of the Green-sand.

7.—*Venus parva;* from Shanklin Cliff.

Pl. V.



FOSSIL SHELLS FROM THE GREEN-SAND STRATA OF THE ISLE OF WIGHT

DESCRIPTION OF PLATE V.

FOSSIL SHELLS FROM THE LOWER GREEN-SAND DEPOSITS.

Fig. 1.—*Thetis minor;* from the ferruginous sand-rock at the base of Shanklin Cliff.

2.—Another view of the same, to show the beaks and hinge-line.

3.—*Gryphea sinuata;* represented one-fourth the natural size; it is often found much larger. From the Green-sand at Shanklin, Ventnor, Sandown, &c.

4.—*Tornatella albensis;* from the Cracker Rocks, Atherfield.

5.—*Terebratula sella;* an abundant shell in the sand at Atherfield.

6.—*Nucula scapha;* from the sand-rock, Atherfield.

The three following shells are imbedded in a fragment of the Crackers' Rock, from Atherfield.

7.—*Natica rotundata.*

8.—*Pterocera retusa.*

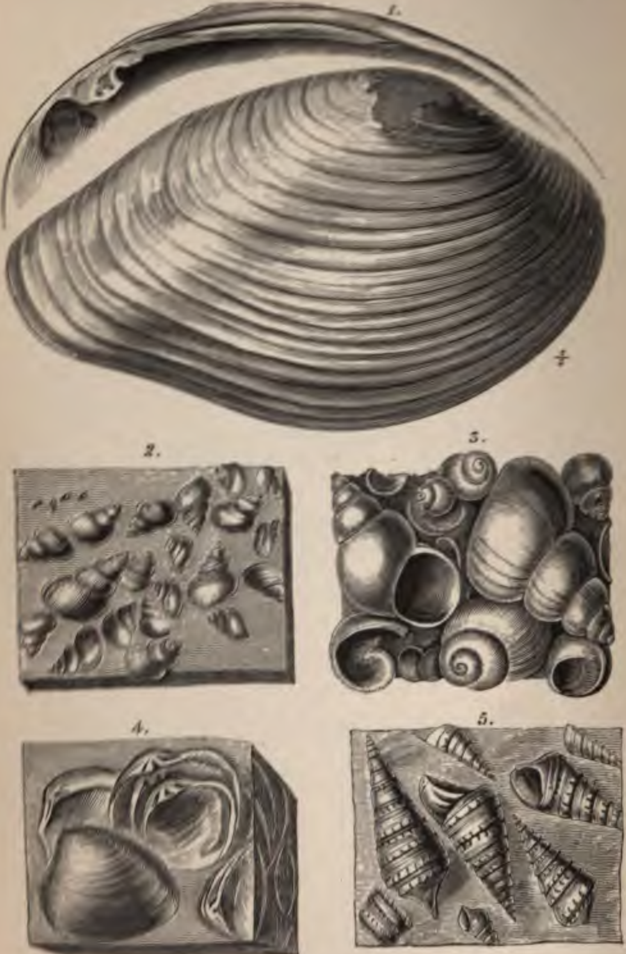
9.—*Rostellaria Robinaldina.*

10.—*Cerithium turriculatum;* from Atherfield.

11.—*Scaphites gigas;* from Atherfield. The figure is but one-third the size, linear, of the original.

This fossil is often found two feet in length, associated with Ammonites equally gigantic.

Pl. VI.



SSIL SHELLS FROM THE WEALDEN STRATA OF THE ISLE OF WIGHT.

DESCRIPTION OF PLATE VI.

FOSSIL SHELLS FROM THE WEALDEN DEPOSITS.

Fig. 1.—*Unio Valdensis*; from the fossil forest at the base of the cliff at Brook-point. A young shell; the figure is two-thirds the natural size in linear dimensions. The uppermost figure gives the inner view of the same shell, to show the hinge and muscular imprints.

2.—*Paludina elongata*, in hard clay, from near Brook-point; large slabs of laminated clay covered with this species, associated with myriads of Cyprides, are continually laid bare by the inroads of the sea.

3.—*Paludina fluviorum*; a portion of a weathered slab of limestone, from Compton Bay.

4.—*Cyrena media*; in a piece of bluish-grey limestone, composed of thin bivalves; from Compton Bay.

5.—*Potamides carbonarius*; a slab of limestone formed of this species of fresh-water shell; from Compton Bay.

I have found the *Unio Valdensis* only in the cliffs, along Brook Bay; the other fresh-water shells are equally abundant in Sandown Bay. The shelly limestones of the Wealden are often used for paving in the towns and villages of the Island.

HINTS FOR VISITORS

TO

THE ISLE OF WIGHT.

As the tourists from Southampton, Gosport, Portsmouth, &c., generally land either at Ryde or Cowes, the following Excursions are so arranged as to afford an explanation of the geological phenomena, when proceeding from either of those towns, to the eastern or western extremity of the island. But as the preliminary sketch of the Geology of the south-east of England (p. 40,) conveys a general idea of the structure of the country, it is immaterial at what place the observer may commence his explorations.

"Brannon's Travelling Map of the Isle of Wight" will be found very convenient for reference; and "Barber's Picturesque Illustrations," which contains numerous excellent engravings of the most interesting scenery, will serve as a beautiful illustrative atlas to our geological descriptions.

Cowes.—In the vicinity of this town there are no interesting sections of the strata easily accessible to visitors, nor any locality rich in organic remains. The blocks of freshwater limestone scattered along the shore contain the usual fossils of the tertiary fluvio-marine deposits.

RYDE.*—The freshwater tertiary strata are fully displayed in the vicinity of Ryde. A delightful walk to the village of Binstead conducts to several quarries of the limestone which is extensively used as a building material along the northern district of the Island. Fine specimens may here be collected of fossil freshwater shells (see Pl. I. and II.): and these quarries are worth visiting again and again, for the chance of finding teeth or bones of mammalia, similar to those which occur at Montmartre, near Paris, and of which some relics have been discovered at Binstead, by Mr. Pratt and Mr. Prestwich. (See Pl. II.) From Ryde, the *Tertiary strata* at Brading, Bembridge, St. Helen's, and White Cliff Bay—the *Chalk* at Culver Cliffs—and the *Wealden* deposits at Sandown Bay—may be visited; and afterwards the *Firestone, Galt,* and *Greensand* of the Chalk formation at Shanklin, and along the Undercliff.

If the direct road from Ryde to the western extremity of the Island is taken, we pass by several quarries at Binstead, on the road-side; and traverse the interior of the Island, by that picturesque spot, Wooton Bridge, to Newport, and from thence to Alum Bay. Grove's hotel, on the summit of the hill, is an excellent resting-place for the visitor desirous of examining the highly interesting tertiary strata at Headon Hill and Alum Bay. From Cowes, by Newport, the same route may be taken.

By the steamers we may proceed to Yarmouth, which is the best locality for surveying the western parts of the Island. The tertiary strata at Colwell Bay, Headon Hill, and Alum Bay, are within a moderate distance;* and magnificent sections of the chalk are displayed from the Needles, along Scratchell's Bay to Freshwater Gate. (See Pl. X.) From the latter place excursions may be made either over Afton and Shalcomb Downs (see Pl. XI. and XII.), or under the cliff, by Compton Bay to Brook Point, where the fossil forest of the Wealden is exposed. From Brook the Atherfield coast-guard station may be visited, where there is a foot-track down the Cliff to the sea-shore, near the junction of the freshwater beds of the Wealden with the marine strata of the Greensand above; a locality which the researches of Dr. Fitton have made classic ground to the geologist.

---

* At Ryde information may be obtained as to the best localities, and mode of visiting them, of Mr. G. Fowlstone, lapidary, 4, Victoria Arcade, who has generally on sale a choice collection of pebbles and other specimens, the *genuine productions* of the Island. Many of the so-called Isle of Wight pebbles are either German or [illegible]!

A pedestrian tour round the Island may be accomplished in ten or twelve days, and the principal localities visited, and a good collection obtained of the organic remains peculiar to each formation. The following notes of a trip made last summer by my young friends, the Messrs. Gladstone, of Stockwell, may perhaps be useful to some of my readers.

Monday.—By railway from London to Southampton—to Cowes by steamer. Examined the blocks of freshwater limestone on the sea-shore, and collected specimens of *Limneus* (Pl. I. figs. 3, 4), *Planorbis* (Pl. I. fig. 1), and other shells. By coach to Newport; walked to Carisbrook Castle, and, after a stroll over the ruins, examined the chalk pits of Mountjoy.

Tuesday.—Rode to Calbourne, and visited the quarries of freshwater limestone. Walked to Grove's hotel on the summit of the hill, over Alum Bay. In the afternoon strolled to the sea-shore at the foot of Headon Hill, and along Alum Bay; collected numerous fossil shells from the freshwater strata at the former, and marine shells from the London clay at the latter place.

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* Mr. Butler, of the Bugle Inn, Yarmouth, an intelligent practical ornithologist, will afford the stranger the requisite information as to the most interesting localities, and the best means of visiting them. He has often accompanied me in my geological rambles.

Wednesday.—Walked over the Downs to Freshwater Gate; and from thence by Afton and Shalcomb Downs to Brook Point, where we examined the fossil forest of the Wealden. Proceeded by Brixton through Atherfield to Blackgang Chine; the unfavourable state of the weather prevented our reaching Atherfield Point.

Thursday.—Proceeded along the Undercliff by St. Lawrence, Ventnor, Bonchurch, and Luccomb Chine, to Shanklin; stopping occasionally to collect specimens, and enjoy the scenery. Went along the shore to Dunnose Point, and gathered numerous fossils, among which were some leaflets of the Wealden fern (*Lonchopteris Mantelli*), associated with *terebratulæ* and *trigoniæ*. Slept at Shanklin.

Friday.—Walked by the sea-side to Sandown Bay, where we collected many Wealden fossils; proceeded to Brading.

Saturday.—Visited the Culver Cliffs and White Cliff Bay, and obtained many fossils similar to those from the north-western part of the Island. In the evening walked to Ryde.

Monday.—Went to the quarries at Binstead, and collected several good specimens of fossil freshwater shells of the same species as those at Calbourne. Left for Portsmouth; visited the Dock Yards; to London by the late train.

These young gentlemen went unattended, and without any previous knowledge of the Isle of Wight, except what they had gathered from conversations with me, and returned home with an instructive series of the organic remains of the island; thus affording a practical illustration of Mrs. Barbauld's admirable story of "Eyes and No Eyes."

DESCRIPTION OF THE PLATES.

ORGANIC REMAINS.

Pl. I.—FOSSIL SHELLS, from the *freshwater Eocene* strata of the Isle of Wight, at Headon Hill, Calbourne, Shalfleet, and Binstead.

Pl. II.—Fossil shells from the same deposits; and teeth of *Mammalia*, from the quarries at Binstead, near Ryde.

Pl. III.—Fossil shells from the *marine Eocene* deposits, at Alum Bay, Colwell Bay, &c.

Pl. IV.—Fossil shells from the *Greensand* strata of the Chalk formation. The *Perna Mulleti*, a very characteristic shell, is here figured.

Pl. V.—Other shells from the *Greensand:* the large *Scaphite,* which occurs in this division of the cretaceous deposits, is represented on a small scale, in Fig. 11.

Pl. VI.—A few characteristic freshwater shells from the *Wealden* strata.

Pl. VII.—A plan of the Geological structure of the Isle of Wight; by Professor John Phillips.

Pl. VIII.—ALUM BAY, FROM HEADON HILL.

This view is taken from the side of the hill, where the pathway from the summit of the Downs winds along the edge of the cliff, to the foot-track that conducts to the sea-shore. In this sketch the nearly vertical Chalk strata, which terminate in the isolated wedge-shaped masses, called "The Needles," are alone visible. The variegated tertiary sands and clays, that impart so remarkable an aspect to Alum Bay from the sea, form the vertical face of the cliff on the left hand of the observer, but are not seen in this sketch. The Isle of Portland appears looming in the remote distance.

Pl. IX.—Tertiary Strata of Headon Hill, from the Sea.

The face of the cliff here represented exhibits a natural section of a series of tertiary strata, principally of freshwater origin, which have been thrown down, unconformably to the marine deposits in the adjacent cliff of Alum Bay; for while the latter are vertical, these are nearly horizontal. The footpath runs from the Downs to the sea-shore, along the steep slope, forming the north side of the chasm that separates Headon Hill from Alum Bay; its situation is indicated by the two upper figures.

Pl. X.—Chalk Cliffs on the west of Freshwater Gate.

The face of the cliffs to the west of the landing-place at Freshwater Gate presents a nearly perpendicular section, 200 feet high, of the Upper Chalk, with numerous layers of flint, the strata being highly inclined. At the base of the projecting cliff is the entrance to a large cavern, formed by the continued action of the surge on the chalk rock.

Pl. XI.—View of the Cliffs from beyond C [illegible] ne to Brook Point, as seen from near Afton Down.

[illegible] und is part of the southern slope of Afton

Down, and consists of the flinty chalk. The pathway winds over the brow, and leads to Compton Chine, down which a rude foot-track conducts to the beach. The strata at this point are the cretaceous ferruginous sands, which emerge from beneath the Galt on the west, and are succeeded on the east by the Wealden deposits; but the face of the cliffs along the westernmost part of Compton Bay is not seen in this sketch. The strata forming the cliffs, shown in this view, are the sands, clays, and shelly limestones of the Wealden.

The first point of land jutting into the sea, and terminating in ledges or reefs, is the western boundary of Brook Bay; at the base of the cliff is the fossil forest of the Wealden. The limits of Brook Bay are shown by the head-land beyond, which is the eastern point. The farthest land on the shore is the Cliff near Blackgang Chine. Saint Catherine's Hill rises in the remote distance.

Pl. XII.—BLACKGANG CHINE FROM THE SEA-SHORE, LOOKING NORTH-EAST.

This view presents a fine natural section of the strata composing the Greensand group of the Chalk formation. The highest point in the distance is the escarpment of Saint Catherine's Hill, which is 830 feet above the level of the sea. The upper part of the cliffs is composed of alternating strata of greenish grey sand and sandstone; from the wearing away of the friable layers the beds of hard grit become prominent, and appear in this view as very distinct, and nearly horizontal, bands of rock. The cliff below the thin bed of ironstone grit, from which the cascade issues, is formed of dark-coloured clay, alternating with ferruginous sand and grit. The long-continued action of the water has produced a deep chasm, or chine, and the stream falls in a nearly perpendicular column from a height

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[illegible] The [illegible]

[illegible] interesting spot is admi- [illegible] Henry Englefield, and by [illegible] on the embellished [illegible] in the Island.

the eastern promontory of the Isle of Wight, which is a vertical section of the chalk range, that extends from this point, in a westerly direction, right through the island to the Needles. The interrupted lines denote the layers of flint, and distinctly exhibit the highly-inclined position of the strata towards the north. The dip varies from 50 to 70 degrees. The distance on the left is Sandown Bay; on the right are seen the eocene strata of White-cliff Bay.

VIEWS ON THE COAST OF THE ISLE OF PURBECK:

Reduced from the beautiful Engravings by Mr. Webster, in Sir Henry Englefield's Isle of Wight.

Pl. XVI.—VIEW OF THE DORSETSHIRE COAST, FROM WORTH BARROW, LOOKING WESTWARD.

This interesting view of the Dorsetshire coast, looking towards the west, is taken from Worth Barrow, a tumulus situated near the summit of a very high precipice of the chalk range. The bay included between the foreground and the detached rocks in the sea is Worth Barrow Bay; the road down to which is seen just beyond the projecting point of the chalk cliff. The rocks bounding the bay are the Purbeck beds, covering the *Oolite*. The long hill in the middle of the view is the Swine's-back, beyond which is West Lulworth Cove. The Isle of Portland appears in the distance, united to the main land by the Chesil Bank. Weymouth road is indicated by the vessels at anchor.

The deep sinuosities made in the cliffs along this coast by the inroads of the sea are well shown in this sketch.*

Pl. XVII.—LULWORTH COVE, FROM THE WEST.

Lulworth Cove is an almost semicircular bay, formed by the action of the sea on the vertical strata which constitute this part of the coast; and in the section thus exposed the series of rocks, from the chalk to the oolite inclusive, may be traced. A small part of the chalk cliff is seen on the left of the Cove, and from that to the entrance, where the oolite appears, the intermediate strata occur. The upright rocks in the sea near the foreground are masses of the Purbeck beds on this side of the bay, while similar blocks appear on the opposite bar. The argillaceous strata on the side of the hill are curiously contorted from lateral pressure.

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* Sir Henry Englefield's Isle of Wight, p. 183.

Pl. XVIII.—West Lulworth and Cove.

The village of West Lulworth is situated in a deep valley, formed by an interruption of the chalk range that extends from Handfast Point, through Corfe Castle, to the coast. The Cove, which has been produced by the erosive action of the sea on the chalk cliffs, is about 1,300 feet in diameter, and vessels of a hundred tons burthen may at all times remain here in perfect security.

The hill immediately above the village is the termination of the long ridge called the Swine's-back, which is half out into the Cove and presents a lofty precipitous chalk cliff. St. Adhelm's head is in the remote distance; the nearer headland, seen above the Cove, is Gad Cliff.

Pl. XIX.—Durdle Cove.

In Durdle Cove the series of deposits, from the upper flinty chalk to the Portland oolite, is exposed in a nearly semicircular bay walled in by vertical sections of these strata. The chalk appears on the right, forming the high cliff termed Bat's Corner; and in passing from thence round the bay, the *Chalk marl, Firestone, Galt, Greensand, W*[illegible] *Purbeck strata,* may be successively traced t[illegible] *oolite,* which terminates the point on the left of the sketch. The natural arched rock, called Barn Door, at the entrance of the Cove, consists of Portland limestone.

Pl. XX.—GEOLOGICAL MAP OF THE ISLE OF WIGHT.

Each of the three *Formations*, or principal groups of deposits, of which the Isle of Wight is composed, is defined by a separate colour.

The *pink* denotes the tertiary *Eocene* strata; the shaded parts indicate the London clay, and other marine beds, in which but few, if any, freshwater fossils occur.

The *blue* marks the *Chalk;* the chief subdivisions of this formation, namely, the *Firestone*, *Galt*, and *Greensand*, being defined by a difference in the lines of shading.

The *sienna* indicates the *Wealden* deposits, which appear in the bays on the east and west of the promontory of the Undercliff.

⁂ For the original sketch of the Geological Map, and for the drawings of Organic remains, I am indebted to the kindness of Professor Woodward, of the Agricultural College, Cirencester.

The lignographs are by Mr. James Lee, of Prince's Square, Kennington Common.

We may, therefore, assume that every intelligent person is aware that the rocks and stones, and solid mineral masses, composing the dry land, have originally been in a softened or fluid state, either from the effects of water, or from exposure to a high temperature; that the strata are accumulations of consolidated mud, sand, and other detritus, the sedimentary deposits of rivers and seas, combined with the durable remains of animals and plants, which lived either on the land or in the water; that chalk is an aggregation of shells, corals, and amorphous particles of carbonate of lime, so minute as to be undistinguishable by the naked eye, yet easily recognisable under the microscope; that the layers and nodules of flint have originated from solutions of siliceous earth in heated vapours or waters that were periodically erupted into the cretaceous ocean; that the fossils so abundant in the chalk are the relics of animals and plants that lived and died in that ancient sea, intermingled with the remains of a few terrestrial species; that these accumulations of organic and inorganic materials have gradually consolidated, and subsequently been elevated from the depths of the ocean by those subterranean forces that are everywhere in action, and of which the earthquake and the volcano are paroxysmal effects; and that such transmutations of the sea and the land have been, and are constantly taking place.

GEOLOGICAL PRINCIPLES.—From the first moment that dry land appeared on the earth's surface, whatever may have been the materials of which it was composed, the disintegrating effects of atmospheric agents, and of water in motion, must have commenced. The detritus thus produced, transported to the tranquil depths of the ocean, would there subside in successive layers, and a series of sedimentary strata be gradually formed; and after the creation of living things, the durable remains of animals and vegetables must have become intermingled with the detritus of the land, and imbedded in the deposits then in progress. If the land were sterile, destitute of vegetation, and untenanted by any species of animals, the relics of the inhabitants of the sea would alone be imbedded: on the contrary, if the sediments were produced by the action of streams and rivers flowing through a country covered with forests, and swarming with animal life, the strata accumulated in lakes and inland bays would teem with the remains of terrestrial and fluviatile animals and plants.

The evidence which fossil remains afford of the changes that have taken place in the organic and inorganic kingdoms of nature, in periods antecedent to all human history and tradition, is, therefore, of the most positive and unequivocal character. If, for example, a series of strata contains exclusively relics of marine fishes, shells, corals, &c., it is obvious that it must have been formed in the sea; the state of the organic remains, and the nature of the species—whether *littoral*, *i. e.* inhabitants of shallow waters; or *pelagic*, *i. e.* species which lived in the depths of the ocean—affording indications as to the circumstances under which the formation of the strata took place. If an intermixture of land and fresh water with marine species occurs, it is evident that rivers and their tributaries brought into the sea the spoils of the land, and the relics of its inhabitants. On the other hand, if an extensive tract is composed of laminated clays, sands, and marls, teeming with terrestrial and fluviatile shells, and containing waterworn bones of land-animals, and branches, leaves, and fruits of trees and shrubs, without any intermixture of marine exuviæ, we have unquestionable evidence that these strata are either the consolidated deltas of rivers, or the sediments of lakes of an extensive continent, which was clothed with vegetation, and tenanted by terrestrial quadrupeds. As the principles involved in these deductions afford an easy interpretation of the geological phenomena of the Isle of

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TABULAR LAND.

Formations.	Subd	Distribution in the Isle of Wight.
I.—DRIFT; or, *post-tertiary deposits.*	Superficial grav flint pebbles,	Fissures in the tertiary and cretaceous strata; the subsoil in some localities.
II. — TERTIARY EOCENE FORMATION. (*Fluvio-marine.*)	Bagshot Sand.	
	Freshwater Strata.	The northern parts of the island. The freshwater beds prevail along the northern shore, from Headon Hill to White-cliff Bay; the marine from Alum Bay, along the northern flanks of the chalk hills, to White-cliff Bay.
	London Clay.	
III.—CHALK FORMATION. (*Oceanic.*)	Upper Chalk.	
	Lower Chalk.	
	Chalk Marl.	The Downs from Culver Cliff to the Needles; and from St. Catherine's to Shanklin Down. The Undercliff and the southern coast are formed by the lower subdivisions of the chalk, except in the two following localities.
	Firestone.	
	Galt.	
	Greensand.	
IV.—WEALDEN FORMATION. (*Fluviatile.*)	Weald Clays.	Sandown Bay, between the Greensand of Red-cliff and Shanklin Chine. Brook Bay and along the coast, between the Greensand of Compton Bay and of Atherfield Point.
	Tilgate-grit, an Hastings Sands.	
	Ashburnham Beds.	
	Purbeck Beds.	

[*To face page* 42.]

ORDER OF SUPERPOSITION.—Such is the chronological sequence of the formations of the south-east of England; in other words, these several groups of marine and fresh-water sediments have been deposited in the following order:—

1st, The *Wealden:* the delta of a river, composed of the spoils of a vast continent, of which no other vestiges remain. These strata rest upon a marine formation called the *Oolite,* but which does not come within the scope of our present observations.

2ndly, The *Chalk:* the bed of an ocean of great extent, deposited upon the Wealden.

3dly, *The Tertiary Eocene Formation:* accumulated in depressions or basins on the surface of the Chalk.*

Now, as each of these formations is many hundred feet in thickness, it follows that the inferior strata would for ever have been concealed from observation, had the original order of superposition remained undisturbed. But not only portions of each of the upper series appear on the surface, but even the lowermost deposits form an extensive tract of country which is diversified by hills and valleys, and constitutes one of the richest agricultural provinces of the British Isles. This distribution of the strata has originated from the displacements occasioned by those disturbing forces which elevated above the waters the ancient ocean and river beds, and converted them into dry land. The nature of those changes we now proceed to consider.

LONDON EOCINE FORMATION.—The London Tertiary or Eocene deposits form the area on which the metropolis is situated, as well as the surrounding country to a distance varying from ten to twenty or thirty miles. Around these strata the Chalk presents a distinct boundary of hills on the south, west, and north; but on the east the range is broken, and though this chasm the Thames winds its way to the sea.

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* With the view of simplifying the subject, the *Drift,* or superficial alluvial deposits, will not be especially alluded to in these excursions.

From this geological character of the metropolitan district it results, that all the lines of railway that proceed from London traverse, for the first ten or twenty miles, beds of clay, loam, and loosely aggregated sand and gravel; hence the numerous slips that have taken place in the embankments at New Cross, Wandsworth, Hanwell, &c.; and in all these lines it is obvious, from the nature of the soil and the steepness of the cuttings, that similar subsidences will again occur.

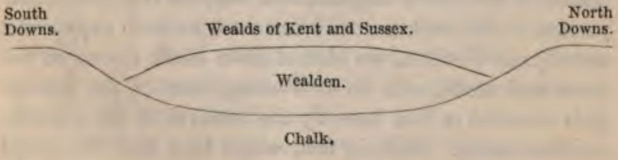
CHALK FORMATION.—The next geological feature observable along the London railways is the *Chalk*, which is invariably traversed by steep cuttings and tunnels; as, for example, in the South-eastern line, from Croydon to Merstham; and in the Great Western, from Maidenhead to beyond Wallingford. After passing through the chalk, the lower subdivisions of the cretaceous formation, viz., the *Marl*, *Firestone*, *Galt*, and *Greensand*, successively appear; and these are followed by the *Oolite* on the Great Western and Birmingham lines, and by the *Wealden* on the South-Eastern; but on the South-Western, by which we shall travel to Southampton, the chalk and the tertiary strata only are exposed.

The chalk, as is well known, constitutes the prevalent geological feature of this part of England. The upper or white chalk rises into chains of hills, called downs, which are remarkable for their smooth and undulated outline, and form a well-defined geographical boundary. The southern range extends from Hampshire, through Sussex to the sea-coast, terminating in the bold promontory of Beechy Head; the northern passes from Hampshire through Surrey and Kent to the British Channel, and ends in the line of [illegible] Dover.

The lower cretaceous strata compose ranges of hills less uniform in elevation and extent, which skirt the inner margin and escarpments of the Downs, and in some parts of Surrey and Western Sussex attain an altitude equal to that of any portion of the North or South Downs. Leith Hill, in Surrey, is nearly 1,000 feet above the level of the sea.*

WEALDEN FORMATION.—The Wealden deposits fill up the whole of the area between the North and South Downs, and are bounded on the west by the cretaceous strata of Hampshire, and on the east by the British Channel. They form the sea-coast from Pevensey in Sussex to Hythe in Kent.

Looking down upon the Wealden from any of the heights that command a view across the district, and of the distant boundary of chalk downs—as, for example, from Leith Hill, or from the summit of the escarpment of the North Downs, near Reigate †—the observer might suppose that these freshwater sediments occupy a depression or basin on the surface of the chalk, and that the strata of the North and South Downs extend under the whole of the deposits in the intervening area, as in the following diagram :—



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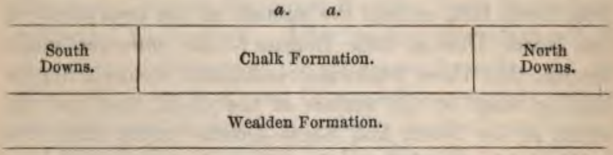
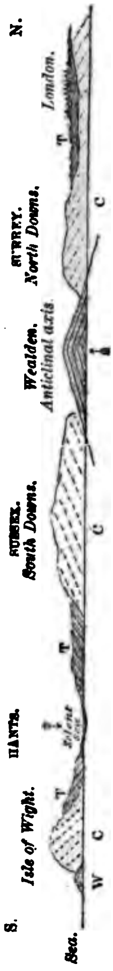
* For details, *vide* a "Memoir on the Geological Structure of the Country seen from Leith Hill," in the County History of Surrey, published by Mr. Ede of Dorking.

† See "Wonders of Geology," vol. i. p. 342.

Several writers on geology have fallen into this error, and indulged in the most absurd speculations accordingly. A slight examination of the relative position of the respective strata where in contact is, however, sufficient to show the incorrectness of this hypothesis, and to prove that the Wealden extends under the chalk, both on the north and south, as shown in the subjoined plan, and in lignographs 2, 3. It is therefore certain that the cretaceous formation was deposited upon the Wealden; and it is equally clear that it originally extended not only over the entire district between the North and South Downs, and was connected on the west with that of Hampshire and Wiltshire, but also that it filled up the space now occupied by the British Channel, and was united with the chalk of the Isle of Wight and of the Continent.



If we assume the original position of these ancient fluviatile and marine formations to have been as represented in the above diagram, and suppose that the middle portion of the chalk *a a* were removed, so as to expose the underlying Wealden, we should have chalk downs on the south and north, with an intervening area of the inferior beds denuded or laid bare by the removal of the superincumbent strata. Such, in fact, would have been the actual state of the south-east of England, if the changes here contemplated had been produced by the wearing away of the chalk from the underlying fluviatile sediments, and the horizontality of the strata had been maintained. But a c[illegible]ation of the phenomena under review shows



T. Tertiary. C. Chalk. W. Wealden.

LIGN. 1.—SECTION FROM LONDON TO THE SOUTHERN COAST OF THE ISLE OF WIGHT.

that the removal of the chalk was not affected by simple denudation, but by a force acting from beneath, which elevated the entire series of tertiary, cretaceous, and wealden formations in a line bearing a general direction from east to west; by which movement an anticlinal* position has been given to the strata on each side the axis of greatest elevation. This axis is denoted in the physical geography of the district by the chain of hills called the Forest-range, that extends from the sea-coast at Hastings through the interior of the country by Crowborough, the highest elevation, to Loxwood, west of Horsham, where the Wealden disappears beneath the overlying greensand strata. In all transverse sections of the district, *i.e.* from north to south—whether on the coast, or inland—the strata on the north of the central line dip northward, or rather to the north-east, and those on the south to the south-west. There are, of course, many local variations in the inclination of the rocks, and numerous lesser anticlinal axes, or *saddles*, as they are provincially termed, and also longitudinal ridges and corresponding valleys running parallel with the principal line of the disturbing force.

In consequence of this displacement of the strata, a section drawn from London through the North Downs, across the Wealden district, through the South Downs, and carried on to the southern coast of the Isle of Wight, would present the arrangement shown in lign. 1.

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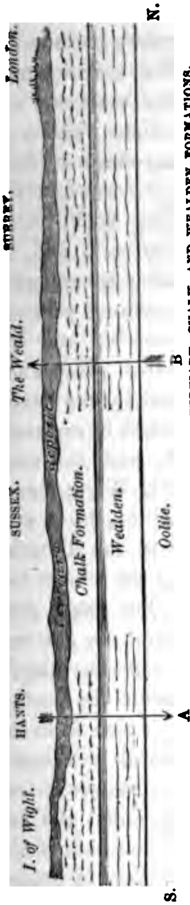
* *Anticlinal*—Inclined towards each other, like the ridge-tiles of the roof of a house.

In this lignograph are represented the *tertiary* of the London basin resting on the chalk; the *chalk* of the *North* Downs, dipping northwards; the anticlinal position of the *Wealden;* the *chalk* of the *South* Downs, dipping southwards, with *tertiary* strata on the southern flank: then the depression which forms the channel of the Solent sea; the *tertiary* strata extending over the northern portion of the Isle of Wight; the *chalk* downs of the Island, dipping northward; and lastly, a small portion of *Wealden*, emerging from beneath the chalk, on the south coast, at Brook and Sandown bays.

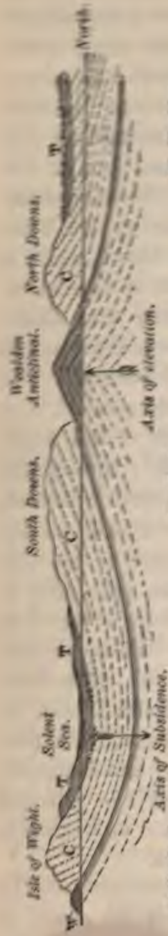
London and Brighton Railway Section.—A portion of this section is well displayed along the line of railway from London to Brighton. Leaving the station at London Bridge, the tertiary clays, with their characteristic fossils, are seen from beyond Deptford, by New Cross, Sydenham, &c.; and approaching Croydon, beds of gravel appear, with interspersions of olive-green sand. The valley beyond Croydon, along the side of which the railway proceeds, is a thick bed of gravel resting on the chalk. Beyond the station called Stoats'-nest, is a fine section of the chalk with flint, and the North Downs are traversed by a long tunnel carried through the solid chalk, and emerging near Merstham, where the firestone and marl rise to the surface. The sands and clays of the chalk are passed at the Red-hill and Godstone stations, and the Wealden clays appear; and at Horley are succeeded by shales, limestones, sands, and sandstones, to the Crawley station. Passing through a long tunnel in the Wealden, we arrive at Balcombe, where laminated sandstone and shale are seen on each side the cutting. The general dip of [illegible] hitherto passed is to the *north-east;* but after



LIGN. 2.—DIAGRAM OF THE ORIGINAL POSITION OF THE TERTIARY, CHALK, AND WEALDEN FORMATIONS.

crossing the deep Wealden valley beyond Balcombe, over a magnificent viaduct, the line runs along alternating layers of sands and clays, which dip to the *south-west;* we have therefore arrived on the southern side of the grand anticlinal axis of the Forest ridge. The Wealden strata continue with the same general inclination by Hayward's Heath, which is traversed by a tunnel, to beyond St. John's Common, where they disappear beneath the lowermost greensand beds of the chalk formation. The galt, firestone, and marl succeed, and lastly, the white chalk of the South Downs, at Clayton Hill; through the base of which a long tunnel is carried, and emerges on the Downs on the south. The remainder of the line to the Brighton station runs over, or through, hills and valleys of the white chalk. Thus this railway passes through two ranges of chalk hills, viz. the North and South Downs, by tunnels; two of greensand, viz. near Red Hill, in Surrey, and Hurstperpoint, in Sussex; and two principal ridges of Wealden, viz. at Balcombe, and Hayward's Heath.

GEOLOGICAL MUTATIONS.—The present distribution of the strata, as shown by the preceding observations, appears to admit of the following explanation. Assuming the original



T. Tertiary. C. Chalk. W. Wealden.

LIGN. 3.—IDEAL SECTION FROM LONDON TO THE SOUTHERN COAST OF THE ISLE OF WIGHT.

deposition of the strata to have taken place as in lign. 2—the Wealden resting on the oolite, the chalk on the Wealden, and the tertiary on the chalk—the surface of the country must have consisted of the same strata as those of the immediate vicinity of London. Now, if any elevatory force acted from beneath, in the direction of the arrow, B, the entire series would be broken through, and the chalk, with the tertiary it supported, thrown into highly inclined positions to the north and south; and if a similar disturbance took place along the area now occupied by the British Channel, England would be separated from the continent, and the small portion, now the Isle of Wight, forced into its present position, by a subsidence taking place in the direction of the arrow, A, along the present bed of the Solent Sea. The actual position of the strata, could our observations extend to a sufficient depth, would probably present the section sketched in lign. 3; which is in accordance with the local phenomena that will come under review in our geological excursions round the Isle of Wight. It is obvious that if the Forest range of the county of Sussex were swept away by the encroachments of the sea, and the area it occupied buried beneath the waves, the North Downs would present a strict analogy in geological structure to the Isle of Wight; for a portion of the Wealden would appear on the south shore at the base of the chalk escarpment, and be succeeded on the north by the greensand, galt, firestone, marl, and white chalk; and the latter would be covered by tertiary eocene deposits.*

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* For detailed information on the geology of the South-east of England, and of the subjects embraced in this concise sketch, see "Elements of Geology," by Mr. Lyell, and the "Geology of the South-east of England," and the "Wonders of Geology," by the Author. On the elevation of the Wealden and the consequent changes in the relative level of the sea and land, the masterly paper of Mr. Hopkins, "On the Geological Structure of the Wealden District and of the Bas Boulonnais" (Geol. Trans. vol. vii.), should be consulted.

CHAPTER II.

SOUTH-WESTERN RAILWAY—STRATA OF THE LONDON BASIN—ARTESIAN WELLS—RAILWAY SECTIONS—SOUTHAMPTON STATION—FROM SOUTHAMPTON TO THE ISLE OF WIGHT—GEOLOGICAL STRUCTURE OF THE ISLAND—RIVERS AND STREAMS—FROM COWES TO RYDE.

SOUTH-WESTERN RAILWAY.—The railway from London to Southampton and Gosport lies so far to the west of the Wealden denudation of the south-east of England, which is traversed by the Brighton line (see p. 50), that all the deposits below the upper chalk are concealed from view, and inconsiderable cuttings through tertiary strata, and chalk, are alone exposed.

The metropolitan station at Vauxhall, on the southern bank of the Thames, is situated on the alluvial silt and loam, which are spread over areas formerly covered by the waters of the river, and now constitute the subsoil of the meadows and lowlands that skirt its banks; these beds contain shells of recent species of fluviatile mollusca. On penetrating the soil, gravel, loam, and sand are met with in which are found bones and teeth of several kinds of large mammalia belonging to extinct species of elephant, rhinoceros, horse, buffalo, elk, deer, &c.; an assemblage of organic remains common in similar deposits in other parts of England and on the Continent.[*]

In the county of Surrey the subsoil of the district traversed by this railway in many parts consists of thick beds of gravel, in which fossil bones and teeth of elephants, horse, and deer, have been discovered; but remains of this kind are more abundant in the loam and clay. The gravel is almost entirely formed of broken chalk-flints, worn by the action of water into boulders, pebbles, and sand. It abounds in siliceous fossils of the chalk, and an interesting series of the sponges, zoophytes, and echini of that formation may be collected from the pits around the metropolis.*

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[*] [illegible] "Geology," fifth edition, vol. i. p. 145.

STRATA OF THE LONDON BASIN.—The tertiary or eocene strata of the London basin which lie beneath the accumulations of drifted materials above described, and fill up a depression of the chalk (see lign. 1, p. 49), are divided into three groups; viz. 1, *Bagshot sands;* 2, *London clay;* 3, *Plastic clay.* The uppermost † consists of beds of sand and sandstone, with intercalations of marl and clay. These strata cover the London clay from near Finchley on the north to Hampstead-heath, and form part of the eminence on which Highgate is situated. The Bagshot sands appear at Egham, and extend, with some interruptions, to near Guildford; and from the vicinity of Kingston to seven miles west of Bagshot, spreading over part of Windsor forest. Several eminences in Surrey are capped by this sand; at Tucksbury-hill, north of Farnham, it occurs at an elevation of 500 feet.‡ From the siliceous nature of the soil formed by these deposits, the districts in which they occur are exceedingly sterile, supporting only a covering of heath and furze; hence the numerous uncultivated wastes within a short distance of London. But where the clays rise to the surface, verdant spots appear in the midst of these desolate tracts. The situation of these argillaceous beds is indicated by the oozing of water, and the growth of rushes in the bottoms of the shallow valleys that traverse the sandy plains, and which are often covered with peat. Some of the Bagshot sandstone is remarkable for its structure, which partakes more of the character of a peculiar crystallization than of a mere aggregation of siliceous particles; a mass of the white variety recently broken strikingly resembles the surface of lump sugar. Erratic blocks of this sandstone are common on the chalk downs of Wilts, Sussex, Kent, &c., and are provincially called the Grey Wethers; they occur also in the superficial drift and gravel.

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* The flints of the gravel often enclose beautiful examples of the microscopic fossils which abound in many of the siliceous nodules of the chalk: some of the most interesting specimens of fossil animalcules in my cabinet were obtained from the gravel on Clapham and Wandsworth commons.

† Bagshot sands; so called from the district over which they are most widely expanded.

‡ Brayley's History of the County of Surrey, vol i. p. 131.

London Clay.—This deposit in the neighbourhood of the metropolis forms a dark-blue stiff soil, and has occasional intermixtures of green and ferruginous sands and variegated clays. It abounds in spheroidal nodules of indurated argillaceous limestone termed *septaria*,* which are internally traversed by veins of spar disposed in a radiated manner from the centre towards the circumference, and often contain shells and other organic remains.† The septaria are generally distributed in horizontal layers, and lie at unequal distances from each other. Brilliant pyrites and crystals of sulphate of lime abound in the clay.

Plastic Clay.—Beneath the extensive and thick deposits of London clay, and interposed between them and the chalk, there occur in some localities strata of sand of various colours, alternating with layers of bluish plastic clay; and there is very constantly in the lower part of the series a bed of green sand, which abounds in oyster shells and pebbles, and in some localities (as near Bromley) passes into a hard rock or shelly conglomerate. Lignite, leaves of land-plants, and freshwater shells are contained in some of these layers; but in many places there are no remains of this kind found in the eocene beds immediately above the chalk; and the term *plastic clay*, as indicating a particular group, can only be regarded as of limited application.*

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* The septaria, when calcined and ground, constitute the composition called Roman cement.

† "[illegible] of Creation," p. 373.

ARTESIAN WELLS.—From the alternation of porous sandy strata with stiff impervious clays throughout the London basin, the district around the metropolis is favourable for obtaining water, by means of the borings, termed *Artesian wells*, by which perennial fountains are raised from the natural reservoir of water in the lowermost arenaceous deposits. The nature of these springs is easily explained. The beds of sand under the clay are fed by the rain that falls on the uncovered margin of the basin, and the water percolating through the porous strata, gradually accumulates till a reservoir is formed beneath the central plateau of clay. If this stratum be penetrated, the water must necessarily rise to the level of the fluid in the highest part of the subterranean lake, and may therefore flow to the surface, or even escape in jets to a considerable height above it. Such is the phenomenon of the Artesian wells in and near London. The impermeable clay confines the water contained in the sand beneath; the engineer perforates this bed with his borer, and introduces tubes for the passage of the pure element to the surface, and the exclusion of the brackish water that may ooze from the saliferous strata above; for although the wells sunk into the London clay yield no water, the sands alternating with the argillaceous beds afford a limited quantity. The prevalence of various saline minerals, however, in the clay, such as the sulphates of iron, lime, and magnesia, generally renders the water derived from this source unfit for domestic purposes; and the borings are carried down to the sands of the plastic clay before a copious supply of excellent water can be obtained.* The total thickness of the London clay, in some situations, is estimated at nearly 1,000 feet; the wells on the Surrey side of the Thames are from 100 to 600 feet deep.

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* The term plastic clay (*argille plastique*) was given to this lowermost division of the eocene strata in conformity with the nomenclature of the French geologists; but the beds thus named are less developed in the London than in the Paris basin, and do not with us possess distinctive characters sufficiently important to warrant their separation from the other intercalated fresh water deposits of this formation.

THE RAILWAY SECTIONS. — The above preliminary remarks will enable the observer to understand the nature of the strata of which transient glimpses may be obtained on each side the railway in the rapid transit from London to Southampton, on which we now proceed without further comment. Although no considerable sections of the eocene strata are traversed by this line, yet here and there the characteristic soil of the London clay may be seen in the cuttings, where the surface has not acquired a covering of turf. On Wandsworth Common the banks on each side are composed of this clay, with a superficial capping of gravel and sand. When the railway was in progress numerous fossils were dug up; and even now the slips of the embankments which occasionally take place expose specimens of nautili and other shells, petrified wood, &c.*

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* The most remarkable instance of success in obtaining a perennial fountain from a deep source by the process of boring described in the text, is that of Grenelle, near Paris. An Artesian well is there carried to the extraordinary depth of 1,800 feet, passing through the entire thickness of the eocene strata of the Paris basin, and the underlying chalk, firestone, and galt, to the greensand. The water rises in a powerful column to the height of 30 feet above the highest part of Paris, and has a temperature of 91 degrees Fahrenheit! being sufficiently warm for the heating of green-houses, &c.

At Esher, the clayey district of the Bagshot sands prevails, and overlies the London clay, which in our further progress is generally concealed by the sands of this subdivision of the eocene strata. At Goldsworth-hill, four miles north of Guildford, a deep section of the Bagshot sands is exposed, consisting of greenish and yellowish sands, in which fossil teeth and other remains of several kinds of fishes (principally of the *Shark* family), and casts of shells, have been discovered. The most interesting fossil obtained is a large tooth of a *Saw-fish*, which, at that time, was the only known instance of the genus *Pristis* in the English strata; but, subsequently, examples of the teeth have been found in the clay of Bracklesham, in Sussex. The other teeth are referable to three kinds of cartilaginous fishes, and with them were associated teeth and palatal bones of *Rays*, and vertebræ of osseous fishes, of species common in the clay of Sheppey; also a portion of the carapace or buckler of a freshwater turtle.†

At Weybridge the banks show an example of false stratification, as it is termed, of white and fawn-coloured sands, with the usual capping of gravel and clay. At Woking Common the Bagshot sands still prevail, their sterile surface being covered with heather and broom, except in a few places, where interspersions of clay pro-

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* See "Geological Survey of Surrey," in Brayley's History of the County, vol. i. pl. 1, 2, in which several of the fossils discovered in the clay of Wandsworth Common are figured.

† Notice of Fossils discovered in the Bagshot Sand at Goldsworth-hill, Surrey, by the Rev. Dr. Buckland. Proceedings of the Geological Society of London, vol. ii. p. 687.

Drift, or alluvial soil . . .	38 feet.
London Clay	304* —
Plastic sands and clays . . .	97 —
Chalk	821 —

This well yields by pumping 15,000 cubic feet of water daily, but the quantity is only one-half of that required; and it will be necessary to continue the borings till the firestone is reached (probably a further depth of from 150 to 200 feet) before an adequate flow of water is likely to be obtained.† The impervious blue chalk-marl or *galt*, which underlies the firestone, generally supports an abundant sheet of water; but whether a stream will rise to the surface is extremely uncertain, and depends on the level from which the water is derived that feeds this subterranean reservoir, and the condition of the basin which sustains it.‡

The branch of the South-western railway that extends to Gosport cuts through a few ridges of tertiary clays, sands, and gravel, capped with drift; but these present no sections of particular interest.§ At Stubbington, between four and five miles west of Gosport, near which the line passes, many interesting fossils have been obtained from the tertiary clays and sands.*

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* Many of the characteristic shells of these strata were brought up by the borer.

† See an admirable Address on this subject to the Mayor of Southampton and the Members of the Artesian Well Committee, by the Very Rev. Dr. Buckland; July, 1845. At the late meeting of the British Association of Science at Southampton, the president, Sir Roderick Murchison, and several other eminent geologists, examined the borings, and recommended the continuance of the operations till the firestone was reached.

‡ In the chalk districts of the South-east of Sussex copious streams of the purest water rise from the junction of the grey marl with the white chalk.

§ Portsmouth and Gosport are built on eocene strata; the wells penetrate the London clay to the depth of from 200 to 300 feet.

SOUTHAMPTON TO RYDE.—The steamers from Southampton to the Isle of Wight generally touch at East Cowes, and proceed to Ryde; those from Portsmouth cross Spithead to the latter town, the distance being scarcely five miles. In the former route we pass down Southampton-water, an arm of the sea which extends ten miles inland in a north-westerly direction, and separates the eastern part of the coast of Hampshire from the New Forest on the west. The entrance of Southampton-water is guarded on the west by Calshot Castle, which was erected by Henry VIII. on the narrow slip of land that here advances some little distance from the line of coast. We now obtain a distinct view of the north side of the "beautiful Island;" and as we approach the land two parallel chains of hills may be observed, stretching in a direction east and west through the whole extent of the landscape. The nearest range is of moderate height, and slopes towards the shore; the distant chain, which bounds the horizon on the south, rises with a bolder sweep and to a much greater elevation, and exhibits the smooth and rounded aspect and undulated outline, which are so characteristic of the mountain masses of the white chalk as to indicate their geological character, even when seen from a considerable distance. The first line of hills consists of freshwater strata, which are superimposed on the eocene marine deposits; the distant range is part of the chain of chalk downs that traverses the island throughout its entire length, forming on the east the promontory of Culver-cliff, and on the west that of the Needles. (See the map, Pl. XX.)

GEOLOGICAL STRUCTURE OF THE ISLE OF WIGHT.—

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* Several species of shells, collected by Mr. Holloway, of Portsmouth, are figured in "Sowerby's Mineral Conchology."

Before we land, and proceed to examine particular localities, it will be necessary to take a general view of the distribution of the three formations of which the island consists. It is shown in lign. 3, (p. 52), that the Solent and Spithead occupy a trough or channel from two to seven miles wide, formed by the London clay and other tertiary deposits which lie upon the chalk. The wells at Southampton, Portsmouth, &c., prove, in the absence of natural sections, that although the strata have undergone great disturbances, the same order of superposition is maintained, as in the south-east of England; and in the southern division of the Isle of Wight, where not only the lowermost cretaceous strata, but even the Wealden, rise to the surface, in consequence of the highly inclined position into which the central mass of rocks has been thrown, the natural order of the deposits is not inverted.*

The Isle of Wight is of an irregular rhomboidal form, being in length, from east to west, twenty-three miles, and from north to south, in the widest part, thirteen miles; the circumference is between seventy and eighty miles. Its surface comprises about 105,000 acres, of which 75,000 acres are under tillage, 20,000 acres are pasturage, and 10,000 acres unproductive heaths and commons. The population is estimated at nearly 45,000.

The map, Pl. XX., shows the range and extent of the respective formations which lie beneath the vegetable soil and superficial loam and gravel. The section in the same plate represents a vertical cut through the island, from Cowes on the north, to the sea-shore beyond St. Catherine's down on the south, and exhibits the relative position and direction of the principal deposits. These are further exemplified by the instructive diagram, Pl. VII., p. 67.

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* The Undercliff presents an apparent exception, for in some instances masses of white chalk are seen covered with beds of firestone, marl, and galt; but these are merely portions of the cliffs that have fallen down in a retroverted position from the encroachments of the sea in comparatively very modern periods.

By a reference to the map it will be seen that the eocene strata which were deposited on the chalk when the latter was in a horizontal position (lign. 2, p. 51), form the northern division of the island. This tract of country is coloured *pink*.

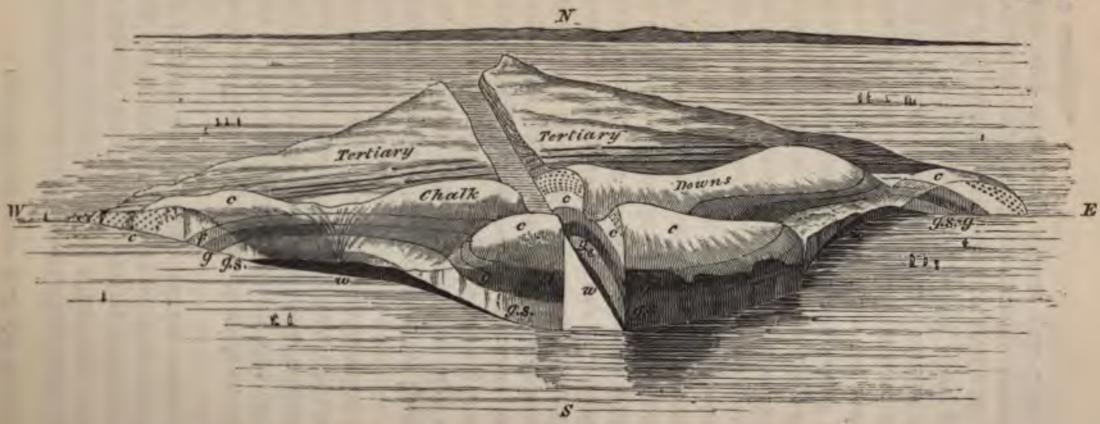
The other portion (coloured *blue*) is almost entirely composed of the different members of the cretaceous system. The white-chalk forms a range of downs from the eastern to the western extremity, and is flanked on the south by the lower beds of this formation. These are succeeded by another group of chalk-hills, that expands into a broad and lofty promontory, in some parts between 800 and 900 feet high, crested by St. Catherine's, Boniface, and Shanklin downs. On the southern escarpment of this chain the inferior deposits of the cretaceous system reappear, and fallen masses of these rocks form the irregular line of terraces which constitute the Undercliff. The downs on the southern coast are separated from those inland by an anticlinal axis which extends through this part of the island, and is produced by the upheaval of the firestone, galt, and greensand. This is shown by the section from north to south, given in the map (Pl. XX.), in which the different members of the chalk formation are defined by variations in the lines of shading, as explained in the index of colours.

The promontory of the Undercliff is flanked both on the east and west by extensive bays, which have been excavated in the clays and sands of the Wealden and inferior cretaceous deposits, by the long-continued encroachments of the sea. The Wealden (coloured *sienna* on the map) occupies an inconsiderable extent of surface; but in Sandown Bay on the east, and in Brixton, Brook, and Compton bays on the west, the cliffs, which are formed of the upper clays and sands of this formation, are exposed to unremitting destruction from the action of the waves. The sea-shore is therefore strewn with the detritus of these fluviatile strata, and the shingle contains innumerable water-worn fragments of the bones of reptiles, and other organic remains.

That the general reader may obtain an accurate idea of the phenomena above described, the diagram, Pl. VII., for which I am indebted to my friend Professor John Phillips, is subjoined. In this plan the geographical features of the island are intentionally exaggerated, that the most important physical characters may be clearly understood. The northern district, consisting of fresh-water and marine eocene deposits, is marked *tertiary*. The chalk downs are seen in their full extent from east to west, the dotted lines denoting the inclined direction of the strata as indicated by the layers of flint nodules; and the lower members of the cretaceous system occupy the southern portion of the island, the principal subdivisions—viz., the *firestone* (*f.*), *galt* (*g.*), and *greensand* (*g.s.*), being marked with letters of reference. The *Wealden* strata (*w.*) are shown in the bays on the east and west of the Undercliff. The vertical cut or section through the Island from north to south explains the position and flexures of the strata, which have given rise to the present geological characters of the surface of the country, the Wealden constituting the foundation and central axis of the island.

RIVERS AND STREAMS.—There is a good supply of water, at a moderate depth, throughout the greater part of the less elevated districts; but the rivers and streams are neither numerous nor considerable. The drainage of the country is chiefly effected by four or five rivers that flow from the northern flanks of the chalk downs. Of these the principal is the Medina, which, rising at the north-eastern base of St. Catherine's Hill, meanders along

Pl. VII.



A DIAGRAM ILLUSTRATIVE OF THE GEOLOGICAL STRUCTURE OF THE ISLE OF WIGHT.

By John Phillips, Esq., F.R.S., &c.

c. Upper and lower Chalk, *f.* Firestone. *g.* Galt. *g.s.* Greensand. *w.* Wealden.

the valley that runs to the east of Gatcombe and Mountjoy. The river flows on to the east of the town of Newport, and soon expands into a wide estuary, which opens into the sea on the north; the towns of East and West Cowes being situated on the banks of the embouchure of the river.

Between Ryde and Cowes there is an estuary fed by springs that issue from the northern foot of Arreton and Ashey downs, and form a considerable breadth of water at Wooton Bridge, called Wooton River. The estuary below the bridge communicates with the sea, and is termed Fishbourne Creek.

The most considerable estuary of the island is Brading Haven, which covers 800 acres, and at high water has the aspect of a beautiful lake; but during low water it is a muddy swamp, through which meanders an inconsiderable river called the Eastern Yar, originating in springs that rise at the foot of the chalk range near Godshill.

Newtown Bay, between Cowes and Yarmouth, is the mouth of a small river of the same name, which is mainly fed by a copious stream that rises near Calbourne.

The Western Yar has its source from springs that burst forth from the foot of the chalk near Freshwater, within a short distance of the southern shore, and quickly expands into an estuary that falls into the sea at Yarmouth, the entire length of the river scarcely exceeding three miles.

Along the southern shore of the Island there are no streams sufficiently large to deserve the name of rivers; but the clay beds that, in some parts of the cliffs, are covered by porous strata many yards in thickness, give rise to copious rivulets, some of which issue from a great height, and, dashing from ledge to ledge, fall into the sea in cascades of considerable picturesque beauty. Those of Shanklin and Blackgang Chines (Pl. XIII.) are well-known examples.

From Cowes to Ryde.—From the highly-cultivated state of that portion of the Island we are approaching, and the luxuriant woods and copses with which it is adorned, its geological construction is almost wholly concealed from view. The water-worn blocks of limestone on the sea-shore, and the layers of tertiary strata exposed in those places where recent encroachments of the sea have undermined the low cliffs which skirt the plantations along the water's edge, afford, however, indications of the nature of the deposits composing this district. As there are no localities of geological interest around Cowes that are accessible to strangers, we proceed to Ryde, the quarries at Binstead, in the vicinity of that town, exhibiting good sections of the fresh-water strata, which extend through the Island from Headonhill on the west, to St. Helen's and Bembridge on the east. On landing at Ryde pier, if at the recession of the tide, it will be instructive to notice the appearance of the surface of the sand and silt that extend along the shore; for it is often deeply impressed with ripple-marks, produced by the action of the waves; and similar appearances will be presented to our notice on the slabs of limestone and laminated clays and shales of the wealden, and other ancient deposits.*

The sea-shore at Ryde, during the last century, has undergone a remarkable change in its geological character, which is worthy of attention. Sir Henry Englefield states that, "when Fielding, in the year 1753, was at s voyage to Lisbon, the town was totally xcept at or near high water, as the tide on ession left a vast breadth of mud, which was too soft bear the lightest weight. But this mud-bank is now ost covered by a layer of fine white sand, which has rmed a surface smooth and firm enough to bear wheel-carriages, and which renders bathing at all times safe and eeable. This bed of sand reaches to Binstead, having, ing the last fifty years, covered two miles of the shore; t is said to be still extending to the westward. To cause this change is owing it is difficult to explain; t is an example of an alternation of deposits from the of the sea in circumstances apparently unchanged."*

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* On a late visit to Ryde, the wind having a few hours previously been exceedingly variable, I found the ripple-marks formed on the surface of the muddy dunes by the agitated waters of a very remarkable character, and strikingly resembling the appearance of the limestone covered with fossil fuci from the Alleghany Mountains; and shortly afterwards I obtained from the Wealden at Sandown Bay a slab of shelly marble, with the upper surface rippled in precisely a similar manner.

escriptions o uresque Beauties, Antiquities, and Isle of Wight, by Sir Henry C.

CHAPTER III.

FRESHWATER EOCENE STRATA OF THE ISLE OF WIGHT—QUARRIES AT BINSTEAD—FOSSIL SCULL OF A REIN DEER—EOCENE STRATA AT BINSTEAD—FOSSIL CHARA—FOSSIL LAND AND RIVER SHELLS—FOSSIL TURTLES—FOSSIL REMAINS OF EXTINCT MAMMALIA.

Freshwater Eocene Strata.—The most remarkable peculiarity in the eocene formation of the Isle of Wight, as compared with that of London, consists in the lacustrine and fluviatile character of the upper series of deposits, which are superimposed on marine strata identical with those of the metropolis. For though in some localities clays and sands, containing marine and estuary shells, alternate with marls and limestones abounding in fluviatile species; and in others the strata are fluvio-marine—that is, contain an intermixture of marine and freshwater shells—yet throughout a considerable thickness of deposits the organic remains are entirely fluviatile and terrestrial. In this respect the tertiary system of the island corresponds with that of the Paris basin, which is characterised by alternations of freshwater marls, gypseous limestones, and siliceous millstones, with marine sands and clays. It was from the gypsum quarries of Montmartre that those relics of extinct mammalia were obtained, which the genius of the illustrious Cuvier called forth from their rocky sepulchres, and invested anew with the forms and lineaments of life.*

In the Isle of Wight the freshwater series consists of eminence on the left, Alum Bay, by a deep chasm; and on the extreme left is the lofty chalk ridge of High-Down, which extends westward into the sea, and terminates in the isolated wedge-shaped masses of chalk, called the Needles. In the remote distance, on the opposite shore, the chalk cliffs, near Swanage, in the Isle of Purbeck, may be distinguished; and likewise the low line of tertiary cliffs on the Hampshire coast, by Barton and Hordwell. On the north-west brow of the hill, commanding a fine view of the entrance of the Solent sea, is Grove's Hotel; a very convenient resting-place for a short sojourn.* From this spot there is a footpath along the north side of the chasm that separates Headon Hill from Alum Bay, which leads to the sea-shore, near the point of separation between the horizontal and vertical eocene deposits. Pl. VIII. is a view from the right-hand side of the hill, about half-way down, showing the vertical face of the chalk cliff which bounds the bay on the south, and extending westward, terminates in the Needles. The Isle of Portland is dimly visible in the remote distance.

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* "Wonders of Geology," vol. i. p. 240.

THE COAST FROM RYDE TO ALUM BAY.—The steam-packets from Ryde to Yarmouth and Lymington pass sufficiently near the northern shore of the Island to afford a general view of the outcrop of the strata in the cliffs and bays formed by the inroads of the sea, and at the mouths of the rivers and estuaries. The coast from Ryde to Cowes presents no features of particular geological interest. Here and there slips or subsidences in the low cliffs have exposed beds of calcareous marl and freshwater limestone, covered by alluvial clay and loam, along the sea boundary of Her Majesty's demesnes of Osborne, and of the grounds of Norris Castle.* Along the shore at low-water numerous fossil shells washed up by the sea are often to be met with.

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* The intelligent landlord has a small collection of fossils, gathered from the neighbouring cliffs; it contained several interesting specimens when I last inspected it.

On the north side of Gurnet Bay, about two miles to the west of Cowes, the cliffs are composed of alternating beds of clay and limestone, the latter abounding in fresh-water shells (especially in *potamides*, Pl. II. figs. 2, 8, 9,) and *gyrogonites*. In Thorney (or Thorness) Bay, similar strata are exposed, with layers of blue clay and sand, containing marine shells.† In several localities along the northern shores of the Island, as for instance, between Ryde and Cowes, and near Cowes, fluvio-marine clays appear on the sides of the sloping banks; but the exact stratigraphical position of these beds is concealed by vegetation; they are probably the equivalents of the strata in the northern end of Whitecliff Bay, that contain an intermixture of marine and fluviatile shells.

Beyond Newtown Bay are Hampstead Cliffs (about three miles east of Yarmouth), consisting of calcareous marls, with the usual fluviatile shells in great abundance. In this locality, leaves of dicotyledonous plants ‡ occasionally occur; and Mr. Prestwich has recently discovered great numbers of an undescribed species of *Cypris*. The lower part of the cliff consists of sand containing freshwater with marine and estuary shells.

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* Mr. Webster mentions that the arenaceous limestone of which the castle is built was quarried near the spot. In these quarries, for ten or twelve feet below the surface, the strata consist of sand and imbedded waterworn blocks of limestone. Sir H. Englefield states that in the low cliff on the shore, the same species of shells as in the limestone occur as perfect as if fresh from the river or lake.

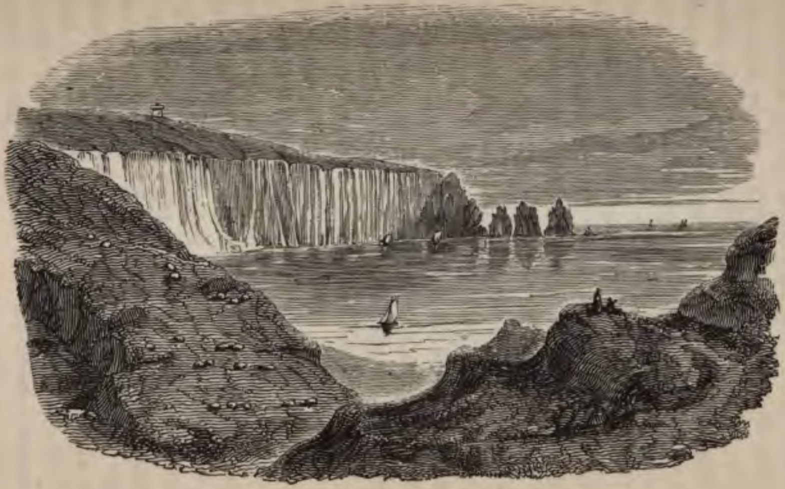
† Mr. Lyell states that the entire buckler with the bones of a tortoise was obtained from Thorness Bay. "Geol. Trans." vol. ii. p. 290.

‡ Similar to those found in the plastic clay at Newhaven, in Sussex, and figured in my "Fossils of the South Downs," Pl. I.

We next pass Yarmouth, and doubling the headland on which was Worsley's Tower, opposite Hurst Castle, enter Colwell Bay, where the cliffs exhibit alternations of marine and freshwater strata. In the fissure called *Bramble Chine* a thick bed of oyster-shells is exposed, apparently in its original state, the valves being in contact with each other as when living; this appears to be the equivalent of the oyster bed observable at Whitecliff Bay. Many beautiful fossil shells may be collected in this locality. The elegant *Cytherea incrassata* (Pl. III. fig. 6), and *Neritina concava* (Pl. II. fig. 5), are found in sandy clay, in as perfect a state as if but recently thrown up by the waves. In Totland, or Tolland's Bay, similar sands, clays, and marls form the cliffs.

HEADON HILL AND ALUM BAY.—We now approach Headon Hill and the richly-coloured vertical strata of Alum Bay. The picturesque character of the dislocated masses of strata forming the face of the cliffs at Headon Hill is shown in Pl. IX. The appearance of Alum Bay from the sea is imposing in the extreme, and is thus graphically described by Sir Henry Englefield:—"The scenery of this bay is very superior in magnificence to that of any other part of the island. The chalk forms an unbroken face everywhere nearly perpendicular, and in some parts formidably projecting, and the tenderest stains of ochreous yellow and greenish moist vegetation vary without breaking its sublime uniformity. This vast wall extends nearly a quarter of a mile, and is more than 400 feet in height; it terminates by a thin projection of a bold broken outline, and the wedge-shaped Needle Rocks rising out of the blue waters continue the cliff in idea beyond its present bounary, and give an awful impression of the stormy ages which have gradually devoured its enormous mass. The pearly

Pl. VIII.



ALUM BAY, FROM HEADON HILL; LOOKING SOUTHWARD.

[illegible]

hue of the chalk under certain conditions of the atmosphere and light is beyond description by words, and probably out of the power even of the pencil to portray.

"The magical repose of this side of the bay is wonderfully contrasted by the torn forms and vivid colouring of the clay cliffs on the opposite side. These do not, as at Whitecliff, present rounded headlands clothed with turf and shrubs, but offer a series of points of a scalloped form, and which are often sharp and pinnacled. Deep rugged chasms divide the strata in many places, and not a trace of vegetation appears in any part. All is wild ruin! The tints of the cliffs are so bright and so varied, that they have not the aspect of anything natural. Deep purplish red, dusky blue, bright ochreous yellow, grey, nearly approaching to white, and absolute black, succeed each other, as sharply defined as the stripes in silk; and after rains, the sun, which from about noon till his setting in summer illuminates them more and more, gives a brilliancy to some of these nearly as resplendent as the bright lights on real silk. Small vessels often lie in this bay for the purpose of loading chalk and sand, and they serve admirably to show the majestic size of the cliffs under whose shade they lie diminished almost to nothing."*

GEOLOGY OF ALUM BAY.—Although the unconformable position and dislocated state of the strata at Headon Hill appear, at first sight, to present but little correspondence with the nearly horizontal freshwater deposits at Whitecliff Bay, and the richly-coloured and variegated stripes of sands and clays of the vertical cliffs of Alum Bay, still less to resemble the dull ochreous marine beds exposed in the breaks of the turf-covered slopes of that locality—yet a careful examination will soon convince the observer, that the geological characters of this north-western section of the eocene strata, agree in every essential feature with those which engaged his attention at the eastern extremity of the Island.* The diagram, lign. 11, will serve to show the close analogy between the deposits of Whitecliff and of Alum Bay. This correspondence, and the extension of the same beds throughout the northern portion of the Isle of Wight, were ascertained and distinctly enunciated by Mr. Webster, in his admirable memoir on the "Strata above the Chalk."†

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* Sir H. Englefield's "Isle of Wight," p. 81.

From the incessant action of the sea on the base of Headon Hill, large masses of the upper beds are continually falling down; and the face of the cliff is generally in so ruinous a state, that the true stratigraphical position of the deposits is seldom visible. Repeated observations have, however, ascertained that the superior beds are nearly horizontal, but curve upwards as they approach the vertical strata, in the same manner as the corresponding layers at Whitecliff. In the sketch, Pl. IX., the upper masses of marl and limestone are lying in this position. The footpath that leads from Grove's Hotel, down the chasm by which Headon Hill is separated from Alum Bay, reaches the sea shore at the point marked *b*, in lign. 11, and which is indicated by the two upper figures in Pl. IX. The visitor, therefore, upon arriving on the strand, has the horizontal freshwater series on the north, and the vertical marine beds on the south, flanked by the lofty chalk cliffs of High-Down, and the Needles.

At Alum Bay, as at Whitecliff, the lacustrine and fluviatile deposits are the uppermost series (lign. 11, *a*);

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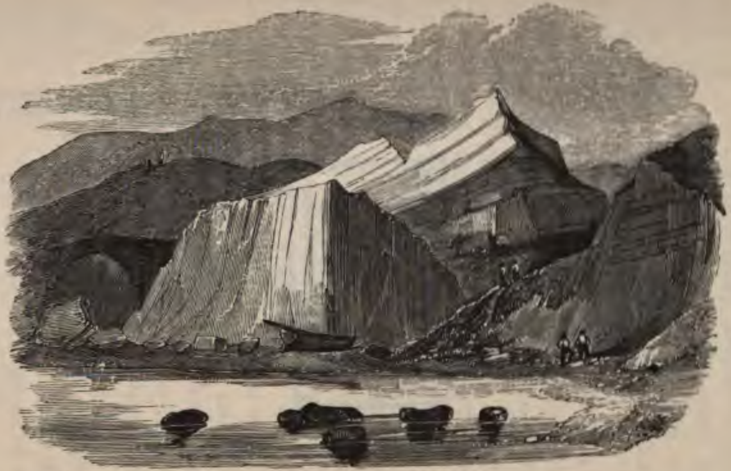
* Mr. Prestwich has given accurate and detailed sections of Alum Bay and Whitecliff, in juxta-position on the same plate, and thus admirably illustrated the relations of the strata in the two localities. "Geol. Journal," No. 7.

† On the "Freshwater Formations in the Isle of Wight," &c. "Geol. Trans." vol. ii. p. 161, first series; 1814.

Pl. IX.



VIEW OF THE STRATA AT HEADON HILL, FROM THE SHORE.

that the commencement of the eocene formation took place in a wide and open sea, the first accumulation of detritus on the water-worn surface of the chalk being an argillaceous sediment, in which no animal remains were imbedded. The earliest group of fossils, the Bognor series, comprises the shells of marine mollusks that do not inhabit deep sea-water, but live in depths averaging from ten to twenty fathoms. This depth, as Mr. Prestwich observes, would be obviously inadequate to allow of the accumulation of detritus sufficient to form strata which, when desiccated, are from 200 to 300 feet in thickness; and as the lithological character of the beds denotes a quiet and uniform deposit for a considerable time, and the fossils indicate an unaltered condition of animal life throughout the same period, a tranquil and gradual subsidence of the sea-bottom must have taken place. The many hundred feet of sedimentary strata which were superimposed on the Bognor series denote a subsequent subsidence to a great depth, to allow of the accumulation of the London clays and sands. This epoch was followed by a gradual transition to an estuarine and lacustrine condition, as shown by the layers of fluvio-marine and freshwater shells. But the freshwater lake or estuary was subjected to occasional irruptions of the sea; hence the beds of oysters, and interspersion of a few marine shells. A barrier was at length raised to the influx of sea-water, and the sediments became exclusively of a fluviatile and lacustrine character. This is proved by the prevalence of freshwater plants, crustaceans, and mollusks; and the presence of bones of terrestrial reptiles, and of mammalia.*

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* This interpretation of the phenomena is a concise expression of the generalisation of Mr. Prestwich, whose admirable "Memoir" should be carefully studied by those who would enter fully into all the bearings of this interesting inquiry. See "Journal of the Geological Society," No. 7.

ORGANIC REMAINS.—Alum Bay and Headon Hill will afford the visitor an abundant supply of fossil shells in great perfection and variety. Figures of a few characteristic species are given in Pl. I. and II.

Potomomya gregaria,	Pl. II.	fig. 1	Headon Hill.
Potamides concavus .	„	„ 2	„
„ plicatus .	„	„ 8	„
„ ventricosus	„	„ 9	„
Planorbis euomphalus	Pl. I.	„ 1	„
Limneus fusiformis .	„	„ 4	„
„ longiscatus .	„	„ 3	„
Paludina angulosa .	„	„ 6	„
Melanopsis fusiformis	Pl. II.	„ 3	„
„ brevis .	„	„ 4	„
Psammobia solida . .	Pl. III.	„ 1	„
Cytherea incrassata .	„	„ 6	„
Corbula cuspidata .	„	„ 2	Alum Bay.
Ancillaria subulata .	„	„ 4	„
Neritina concava . .	Pl. II.	„ 5	„
Ditrupa plana . . .	Pl. III.	„ 3	„
Panopæa intermedia .	„	„ 5	„
Cardita planicosta .	„	„ 7	„

Teeth of two species of Palæotherium (*P. crassum* and *P. medium*,) were obtained by Mr. Prestwich from Headon Hill; and I have seen a block of limestone, in which were imbedded several ribs of a small mammalian, from the same locality.

A few species of crustaceans have been collected from the blue London clay, near the footpath. Gyrogonites, and impressions of dicotyledonous leaves, and lignite, are the only vegetable remains I have observed.

The fluvio-marine and freshwater shells may be collected in great numbers from the fallen masses of strata that lie on the sea-shore. In the marls, the shells of the limnei, planorbes, &c., are well preserved; a chisel will be required to extract them. Thousands of the small species of *potamides*, *melanopsis*, &c., will be found on the strand, having been washed out of the clays and sands composing the cliff. Very fine specimens of several species of marine shells may be obtained from the dark clay at the point marked *b*, in lign. 11. The spot which I have found most prolific is the base of the cliff at the commencement of the footpath, near the sea-shore.

YARMOUTH AND LYMINGTON.—It is unnecessary to extend our remarks on the eocene formations of the Island; from what has been advanced, the intelligent visitor will readily comprehend the geological phenomena observable in the localities not comprised in our excursions. But before entering upon the examination of the next system, the *Chalk*, we would recommend a brief sojourn at Yarmouth; which is a convenient location for the geologist to visit Totland and Colwell Bays, Hampstead Cliff, and a few places on the opposite coast of Hampshire, which have long been celebrated for their organic remains.

The town of Lymington is situated on the western bank of the river of the same name, about four miles from Yarmouth, across the Solent Sea; to this place there are steam-packets from the Island several times in the day. The town is spread over a low hill of tertiary strata. Near the brick-kilns on the eastern bank of the river, not far from the toll-gate, a deep excavation has been made in beds of sand and clay, containing fossils.* An alluvial layer of gravel, ten feet deep, lies upon laminated blue and greenish clays, with interspersions of lignite, four feet in thickness. The next stratum is fine white sand, like that of Headon Hill and Hordwell Cliff, six feet; and beneath is blue (London?) clay, to an uncertain depth. In this clay I found several vertebræ and dermal bones of a crocodile, (*Crocodilus Spenceri*,†) and a few fragments of bones of turtles. I observed no vestiges of shells, but learnt from the workmen that several kinds were occasionally found, and also many bones, but none had been preserved.*

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* This section was open in 1845.

† A well-known species of the London clay at Sheppey.

CHRISTCHURCH BAY.—Christchurch Bay is a semi-elliptical excavation, about eleven miles long, formed by the action of the sea on the Hampshire coast, which is here composed of an extension of the eocene strata of the north-west part of the Isle of Wight; the two portions being now separated by the British Channel, which flows into the Solent Sea. The westernmost point of the bay is Hengistbury Head, near Christchurch; the easternmost is the bar of shingle on which Hurst Castle is situated. Along the line of coast bounding the bay, there are several places in which sections both of the marine and freshwater strata are exposed; and Hordle, or Hordwell Cliff, near the little village of that name, has long been known as an inexhaustible mine of fossil relics. So long since as 1766, a quarto work was published in illustration of the organic remains of this locality, with engravings, which, for accuracy and artistic skill, far surpass most of the modern figures of objects of this kind.†

Hordwell is about midway between Lymington and Christchurch; but from Yarmouth, in fine weather, a boat offers the most convenient transport. Hurst Castle, which guards the narrow part of the Solent Strait, here not a mile across, is built on the extremity of a bar of shingle, that extends nearly two miles from the mainland, on the eastern part of Christchurch Bay. This bank consists of waterworn chalk-flints, and gravel derived from the alluvial drift, which is so largely distributed over the coast district. "It is remarkable," as Sir Henry Englefield observes, "for its uncommon solidity; for it is merely a submarine cliff of shingle, 200 feet high, the depth of the channel close to the castle being 33 fathoms; and the tide flows through it with a rapidity which, at certain times, no boat can stem; yet this natural breakwater has remained unmoved for centuries."*

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* This brief notice is inserted to direct attention to a locality hitherto, I believe, unexplored. I recommended the workmen to save every shell, bone, and tooth, they might meet with. Some future visitor will, perhaps, reap the benefit of the suggestion.

† "Fossilia Hantoniensia collecta et in Musæo Britannico deposita, a Gustavo Brander, Londini, 1766." "Hampshire Fossils," &c. with nine plates, containing 131 figures.

At the junction of the bar of Hurst Castle with the mainland, a low bank of gravel extends for about a quarter of a mile, and is succeeded by tertiary sands and clays, which gradually rise into cliffs 200 feet high; the first mile and a half being Hordwell Cliff, properly so called, which reaches to Long-mead End. From this spot to a ravine formed by a stream at Beacon Bunny, a distance of half a mile, the cliff is named Beacon Cliff. The next two miles and a quarter is Barton Cliff, which is terminated by a stream at Cherton Bunny; and the remainder of the line to near Muddiford, is High Cliff.† The alluvial gravel which forms the subsoil of so large a portion of this coast, appears at the top of the cliffs in a bed varying from twenty to fifty feet in thickness.‡

STRATA OF HORDWELL CLIFF.—The eocene strata in the coast sections have in no instance a vertical, or even highly inclined position, but gently dip to the east. The Headon Hill series first appears, and constitutes the Hordwell Cliff; and the London clays and sands which rise to the surface at Barton Cliff, form the remaining portion of this line of coast. The strata of Hordwell Cliff consist of alternating beds of marl, sand, and clay, often of a greenish colour, with thin bands of indurated shell-marl full of the usual freshwater species. Mr. Searles Wood mentions that a thin seam of sandy clay, abounding in marine shells, is intercalated with these lacustrine strata a few paces westward of a ravine that is situated half a mile from the village of Milford. It is about ten or twelve feet above high-water mark, and extends many yards along the cliff.* The freshwater beds continue as far as Beacon Bunny, and in the upper part of that ravine, beneath the alluvial gravel, there is a bed of fluvio-marine sand, containing an intermixture of estuary and fluviatile shells, which may be traced to the eastward under the freshwater marl, to about 300 yards from Mead-end, where it disappears beneath the shingle of the beach.† This is succeeded by a fine white siliceous sand, like that at the base of Headon Hill, forming a stratum from 60 to 100 feet thick. The London clay series next appears, and extends through Barton and High Cliffs. The upper portion of the beds consists of sandy clay of a dark green colour, like that at the base of the cliff in Alum Bay (marked *b* in lign. 11), and abounds in marine shells; beneath are layers of septaria.

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* See Sir H. Englefield's "Isle of Wight," p. 14, for many interesting remarks on the bed of the Solent.

† These localities are accurately described by Mr. Webster, in his second "Memoir," and are here introduced that the visitor may have no difficulty in finding the places hereafter mentioned as yielding certain species of organic remains.

‡ The stratification of the coast, from the west of Christchurch to the chalk at Studland Bay, in Dorsetshire, a distance of seventeen miles, is described by Mr. Lyell, in "Geol. Trans.," vol. ii. p. 279.

The strata at Hordwell Cliff are regarded by Mr. Lyell as the equivalents of the lacustrine beds which form the coast from Yarmouth to Gurnet Point, where the strata lose the character of an indurated calcareous marl, and are not unfrequently of a bright green colour, like many of the layers of marl and clay at Hordwell. Detailed descriptions of the strata and their fossils are given by this eminent geologist in the second volume of the "Geolog. Trans;" the following summary will be useful to the visitor:—

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* The new "London Journal of Palæontology and Geology," p. 2.

† Mr. Searles Wood *loc. cit.*

1. Alluvial gravel, forming the top of the cliff; composed of broken chalk-flints, with interspersions of sand and marl; thickness from 5 to 50 feet.
2. Fine white sand with greenish marl;—from 3 to 12 feet.
3. Green marls, with arenaceous clays;—16 feet. Contain bituminous wood and seed-vessels, with shells of the genera helix, unio, melanopsis, planorbis, and other lacustrine species. The lowest stratum is laminated marl, with layers of *Cyprides*.
4. Sands and clays;—15 feet. Numerous shells of the *mya gregaria*. Lignite occurs in a layer of bituminous clay.
5. White calcareous marl, largely constituted of aggregated freshwater shells; contains gyrogonites (see p. 78). It rests on a layer of black carbonaceous clay, with lignite; 1 foot.
6. Green unctuous and arenaceous marls; the lower portion consists of beds of pure white sand, with argillaceous sands; —15 feet. Numerous fluviatile shells. The white sand contains abundance of the shells of a small mussel (*mya plana*) in a very perfect state.
7. Light-green calcareous and sandy marls, with layers of a carbonaceous clay containing lignite;—22 feet. Numerous shells, and seed-vessels.
8. Green marl, carbonaceous clay and lignite, ferruginous clay, marl *with vegetable impressions,* and green clay;—9 feet. Freshwater shells, principally two or three species of bivalves.
9. White siliceous sand, without shells; rises near Long-mead End, and extends through Beacon and Barton Cliffs to the middle of High Cliff.*

Near Bournemouth, a little watering-place on the Hampshire coast, between Hengistbury Head and Poole Harbour, dicotyledonous leaves, in a carbonised state, of the same species of plants as those found in Alum Bay (*ante*, p. 117), occur in a sandy marl, which traverses a cliff of firmly aggregated white sand.* I am informed by William Smart, Esq., of Cranbourne (to whom I am indebted for many interesting specimens of these fossil leaves), that the seam of marl is only four inches in thickness, and is limited to a few yards of the cliff, near the base; it is about midway between Bournemouth and Boscombe Chine.

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* "On the Freshwater Strata of Hordwell, Beacon, and Barton Cliffs, Hampshire," by Charles Lyell, Esq. "Geol. Trans." vol. ii. p. 287, Second Series.

In addition to the fossils previously discovered, Mr. Searles Wood has recently obtained the remains of five genera of mammalia and of one alligator, consisting of a jaw with all the teeth, of lizards, serpents, and birds. The following remarks on the geological phenomena observable at Hordwell Cliff are too pertinent to be omitted:—"From the examination of the various strata which are exhibited in the beautiful section of Barton and Hordwell Cliffs, and of their peculiar fossils, one may follow in imagination the gradual silting up of an estuary, and its passage eastward into a pure river deposit. Leaving the regular beds of London clay, which dip gradually to the eastward, and are lost in the beach below Beacon Bunny and Long-mead End, we meet with a stratum of sand in which marine and freshwater shells are intermixed, and one of clay containing leaves and seeds, with an extensive layer of lignite. Upon this is a bed whose organic contents display a still nearer approach to freshwater origin by the absence of the more decidedly marine genera, as *oliva*, *natica*, &c., and the presence of *cyrena*, *potomomya*, &c., in great abundance. Next comes a layer of brown sand, containing rolled fragments of bones of *palæotherium*, *trionyx*, &c., which, from their appearance, may have been transported from a considerable distance. Over this rests a deposit of marl and white sand (No. 6 in Mr. Lyell's section), the latter in the state of an impalpable powder; in this were deposited nearly all the fossils above-mentioned. The strata incline to the east at an angle of about 5°. The direction of the stream was no doubt westerly—that is, toward the marine beds; but at the spot at which I obtained so many interesting fossils there were indications of a contrary current; a circumstance, however, which may very probably have depended upon a sudden bend in the river. The uniformly fine character of the sand, and the condition in which it was thrown down, would lead me to infer that the flow of the stream was extremely gentle. The gradual disappearance of marine species, such as are found at Longmead End, and their replacement, as we proceed eastward, by species of freshwater origin, is just such a succession as we should expect to meet in tracing the course of a river upwards from its mouth."*

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* "Medals of Creation," vol. i. p. 193.

HORDWELL FOSSILS.—The numerous marine fossil shells which are obtained from this part of the coast of Hampshire are generally known as Hordwell fossils, but it is scarcely necessary to remark, that they almost entirely belong to the London clay strata, and are procured from Barton Cliffs. These fossils are most conveniently obtained from the low cliff near Beacon Bunny, and occur in greatest abundance in the upper part of the dark green sandy clay. There are generally blocks of the indurated portions of the strata on the beach, from which fossils may be extracted. It was from Barton Cliff that Brander's fossils† were obtained. Sowerby's "Mineral Conchology" contains figures of numerous species and genera.‡

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[*] The new "London Geological and Palæontological Journal," *loc. cit.*

[†] Fossilia Hantoniensia.

[‡] A collection of Hordwell fossils, consisting of teeth of several species of sharks and rays, bones of turtles, and a great variety of shells, may be purchased at a reasonable price of Jane Webber, dealer in fossils, Barton Cliff, near Christchurch.

The freshwater shells, and the remains of plants and land animals, are to be looked for in Hordwell Cliff, and in the fallen masses lying on the strand.*

In conclusion, it may be remarked that shells of those beautiful chambered cephalopoda, the *nautili*, are seldom, if ever, observed in the eocene strata of these cliffs, or in those of the Island; though the *nautilus imperialis* is not uncommon in the septaria on the western coast of Sussex, and in the London clay at Sheppey.

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* The highly interesting specimens which have rewarded the recent investigations of Mr. Searles Wood will doubtless induce many a collector to visit the spot. The lower jaw of the *Alligator Hantoniensis*, a coloured plate of which embellishes the first number of the new "London Geological Journal," is one of the most splendid British fossils hitherto discovered. Plate 2 of the same work contains figures of some of the mammalian remains discovered at Hordwell by Mr. S. Wood.

CHAPTER VI.

THE CHALK FORMATION — SUBDIVISIONS OF THE CRETACEOUS SYSTEM—RANGE OF THE CHALK IN THE ISLE OF WIGHT—THE UPPER AND LOWER CHALK—CHALK AND FLINT—SILICIFIED FOSSILS OF THE CHALK—THE FIRESTONE—THE GAULT—THE GREENSAND—SUMMARY.

THE CHALK FORMATION.—The different members of the *Cretaceous system*, though presenting considerable variety of lithological character, are yet essentially of the same type, and are linked together by a peculiar fauna, indicating the prevalence of a similar oceanic condition throughout the vast period of time comprised in this geological epoch.

The features of a chalk district are so well known, that a brief notice of the physical geography of that part of the Island which is composed of the cretaceous strata, will suffice for our present purpose; and a reference to the map, Pl. XX., will render local details unnecessary. The rounded summits of the hills covered with short verdant turf—the smooth undulated outline of the downs unbroken save by the sepulchral mounds of the early inhabitants of the country—the coombes and furrows ramifying and extending into the deep valleys which abruptly terminate at the base of the hills, and appear like dried up channels of rivulets and streams, though free from all traces of alluvial debris—thus bearing the impress of physical operations of which the agents that produced them have long since passed away—are phenomena familiar to every one who has travelled over the downs of the south-east of England, and are displayed in striking characters in the chalk districts of the "beautiful Island." These features are restricted to the hilly districts of the *white chalk*, and have resulted from the peculiar nature of the sedimentary detritus of which the strata comprised in the upper division of the cretaceous system are composed. For in the lower groups clays, marls, sands, and sandstones prevail; and where these deposits approach the surface and form the subsoil, the country is broken and diversified, and the landscape presents a striking contrast with the down scenery, as may be observed in the picturesque district which flanks the escarpment of the chalk hills.

It may perhaps be necessary to remind the unscientific observer that these strata are but an insulated portion of an ancient sea-bottom, or, in other words, a mass of consolidated sediments formed in the profound depths of the ocean, in a very remote period of the earth's physical history. This detritus is made up of inorganic and organic materials: the former consist of the debris of the cliffs and shores which encompassed the ancient sea; of the spoils of islands and continents brought into the ocean by freshwater currents; and of chemical deposits thrown down from mineral solutions. The organic substances are the durable remains of animals and plants which lived and died in the ocean, and of fluviatile and terrestrial species that were transported from the land by rivers and their tributaries; the whole forming such an assemblage of sedimentary deposits as would probably be presented to observation, if a mass of the bed of the Atlantic 2,000 feet in thickness were elevated above the waters, and became dry land.

SUBDIVISIONS OF THE CRETACEOUS SYSTEM.—The nomenclature of the chalk formation has undergone so many alterations that, to avoid confusion, it is necessary cuttle-fish in lias,[*] the soft parts of cephalopoda in flint,[†] and the capsule of the eye and the membranes of the stomach of certain fishes, in chalk.[‡] In flint such specimens are by no means rare, and, from the semi-transparency of that mineral, are easily detected. The annexed figure (Lign. 12) represents the body of a rotalia in its shell (highly magnified) imbedded in an atom of flint, in which there is another example, and some other organisms. The shells of *rotaliæ* in the chalk also contain the body of the animal; and by dissolving the chalk and the shell in weak hydrochloric acid, and immersing the residue in a transparent medium (Canada balsam), the soft parts are as distinctly seen as in a recent dead specimen.[§]

So little attention has been paid to the white chalk fossils of the Island, that a few of the common species of *terebratula*, *spondylus*, and *echini*; teeth of sharks; *ventriculites*, *choanites*, and other zoophytes, comprise almost all the specimens I have observed in private collections; but there can be no doubt that were the quarries and natural sections diligently examined, an interesting series might be obtained.[‖]

THE FIRESTONE.[¶]—The lower white chalk, in some places, as at Dover, gradually passes down into a bluish-grey chalk, and the latter into an argillaceous limestone, well known by the name of chalk-marl. In other localities the chalk maintains its purity to its junction with the marl. An intermixture of greensand characterises the latter in many districts, and this variety passes into a hard calcareous sandstone, termed in Surrey Firestone. Deposits of green, sand, with layers and concretions of chert, and seams and nodules of coarse chalcedony, characterise this group in some districts, and are largely developed in the Undercliff. The bands of siliceous limestones and calcareous sandstones, with veins and nodules of chert which appear in the inland cliff of that district, belong to this division of the cretaceous system.

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[*] Dr. Buckland, "Bridgewater Treatise."

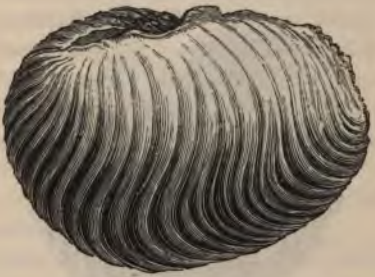
[†] Professor Owen on the Belemnite.

[‡] "Wonders of Geology."

[§] A memoir on this subject, by the author, will be found in the third part of the "Philosophical Transactions for 1846."

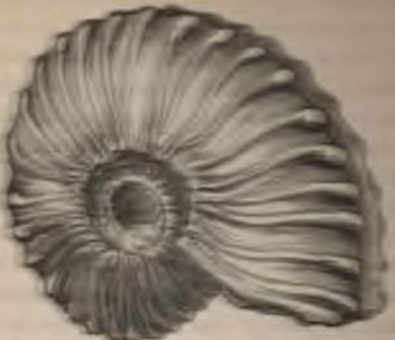
[‖] Figures and descriptions of British chalk fossils are given in my "Fossils of the South Downs," "Wonders of Geology," and "Medals of Creation," and "Geology of the South-East of England;" in Sowerby's "Mineral Conchology," Mr. Lyell's "Elements of Geology," and in Parkinson's "Organic Remains of a Former World."

[¶] The name Upper Greensand, generally given to these arenaceous marl beds of the chalk formation, has been productive of so much confusion that the provincial term, Firestone, however inapplicable as a descriptive term, seems preferable.

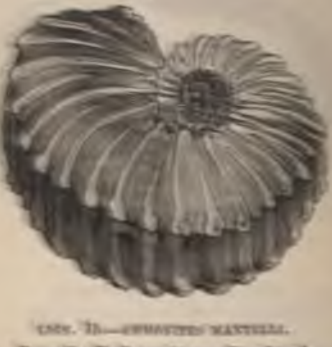


LIGN. 13.—NAUTILUS ELEGANS.
From the Chalk-marl, near Ventnor.

The chalk-marl in most localities abounds in fossils; it contains numerous species of ammonites, nautilus, turrilites, and other cephalopoda, which are either of excessive rarity, or altogether absent in the upper chalk strata. The nautilus and ammonites figured in the subjoined lignographs, 13, 14, 15, are characteristic species of the chalk-marl. The specimen of *Nautilus elegans*, lign. 13, is a young shell: this species is often two feet in circumference.



LIGN. 14.—AMMONITES VARIANS.
From the Chalk-marl, near Bonchurch.



LIGN. 15.—AMMONITES MANTELLI.
From the Chalk-marl, near Bonchurch.

Some localities of the Island are extremely prolific in organic remains, and have yielded to the researches of Capt. Ibbetson an interesting series.* J. M. Saxby, Esq., of Bellevue House, has recently collected many species from

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* There is a good suite of marl fossils belonging to this gentleman, exhibited in the Isle of Wight model-room of the Polytechnic Institution of London.

Bonchurch and Ventnor. A list of the fossils obtained by Dr. Fitton from these strata, chiefly from the cliff at Western Lines, is given in "Geol. Trans." vol. iv. p. 202.

THE GALT.—This is a deposit of very dark blue marl, having an average thickness of 100 feet; the clay in many places has a large intermixture of greensand, and is traversed by thin layers of red marl. It presents no distinctive mineral aspect, but is characterised by the abundance, peculiarity, and state of preservation of its fossils. Numerous species of ammonites, hamites, and other cephalopoda, with their nacreous shells entire, and bivalves and gasteropodous univalves, seldom if ever found in the strata above or below, may be collected from most localities where the galt is exposed in natural or artificial sections of any considerable extent. This deposit is seen on each side of the anticlinals on the southern coast, and in some parts of the Undercliff, near Ventnor and Bonchurch; I believe only a few fossils have been observed.

THE GREENSAND.—This division of the cretaceous system comprises numerous alternations of argillaceous and arenaceous strata of great thickness and extent, constituting an important group, which is well defined by the fossil remains.

It consists of cherty and calcareous sandstones, and sands of various colours, white, green, grey, red, brown, fawn, yellow, and ferruginous: the predominance of the green sands in some districts having suggested the term now employed to designate the group. It was called the ironsand where the ferruginous character predominated, as in the Isle of Wight.* Thick beds of sandy and ferruginous clay, are intercalated with the arenaceous strata. The greensand is separable into three divisions, as was first shown by Dr. Fitton, whose indefatigable and successful labours have so largely contributed to the elucidation of the characters and relations of the deposits between the chalk and oolite in England.

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* The whole series is described by Mr. Webster as the ironsand, in his various memoirs on the geology of the Isle of Wight; and the unfortunate application of this term to the sands of the Wealden districts of Surrey, Kent, and Sussex, retarded, for a long period, the true exposition of the nature and relation of those deposits.

In the upper or Shanklin sand series, the strata are chiefly ferruginous sands with ironstone and concretions of chert, with dark clays in the lower part. The middle group is marked by the prevalence of green and grey sand with beds of calcareous sandstones, and cherty limestone, called Bargate-stone in Surrey, and Rag in Kent. In the lowermost or Atherfield series the argillaceous character predominates. The beds of sand abound in peculiar fossils, and the concretionary limestones and sandstones contain characteristic organic remains. This general notice will suffice, as the details of the sections exposed along the southern coast of the Island have been worked out by Mr. Webster, Dr. Fitton, Captain Ibbetson, Professor Forbes, and other eminent observers, and are published in the Transactions and Journal of the Geological Society.

The following species of shells from the Greensand of the Isle of Wight, are figured in Plates IV. and V:—

Corbis corrugata, Pl. IV. fig. 1. This and the following figure represent but one side of the bivalves, and therefore do not convey an idea of the form of the entire shell; but the markings on the surface are distinctly given, as affording the easiest comparison for the inexperienced collector.

Trigonia caudata, Pl. IV. fig. 2. This shell is so remarkable both in its form and sculpture, as to be easily identified.

Gervillia anceps, Pl. IV. fig. 3. Entire beds of this shell occur in some of the sands at Atherfield. The species is generally more elongated than in the individual figured.

Venus striato-costata, Pl. IV. fig. 4. A small and easily recognised shell.

Venus parva, Pl. IV. fig. 7. In ironstone nodules in Shanklin cliff.

Arca raulini, Pl. IV. fig. 5.

Perna mulleti. Pl. IV. fig. 6. This large and remarkable bivalve occurs in great numbers in a thick layer immediately above the junction of the greensand with the Wealden, at Atherfield and Sandown-bay. The prolonged hinge line is commonly broken off in extracting the shells from their matrix, unless due care is taken.

Thetis minor, Pl. V. figs. 1, 2. These are only casts in ironstone, the shell having perished. They are abundant in the concretions from the ferruginous sand on the top of the cliff at Dunnose Point, that have fallen on the shore.

Gryphea sinuata, Pl. V. fig. 3. This shell attains a large size; specimens are numerous along the shores at Shanklin, Ventnor, and in Compton-bay; being washed out of the cliffs of greensand.

Terebratula sella, Pl. V. fig. 5. This shell in a very perfect state is found by hundreds in the greensand at Atherfield, &c. It occurs in great numbers in the greensand-pits at Faringdon, in Berkshire.

Nucula scapha, Pl. V. fig. 6. This and the following small shells abound in the Atherfield Crackers-rock.

Tornatella albensis, Pl. V. fig. 4.

Natica rotundata, Pl. V. fig. 7.

Pterocera retusa, Pl. V. fig. 8.

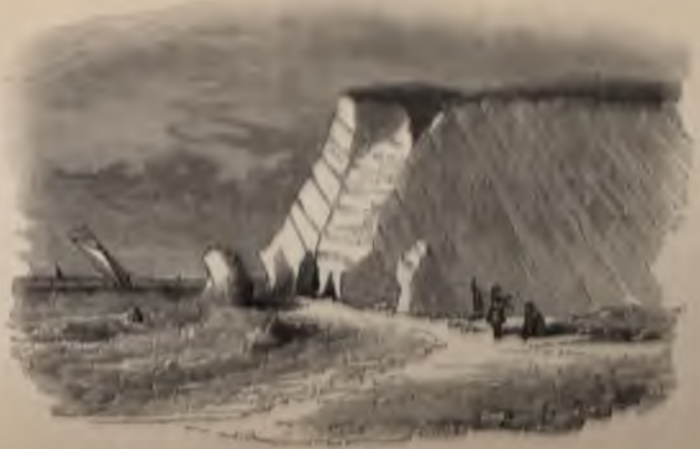
Rostellaria robaldina, Pl. V. fig. 9.

Cerithium turriculatum, Pl. V. fig. 10.

Scaphites gigas, Pl. V. fig. 11. This shell attains a large size; specimens two feet long are sometimes found. The collections of Capt. Ibbetson and Mr. Bowerbank contain splendid examples. Imperfect specimens of the spiral part have been described under different generic names.

SUMMARY.—The character of the cretaceous system, as shown by these investigations, is that of an ocean-bed formed in a vast basin by successive accumulations of sedimentary detritus, transported by currents, and thrown down in the tranquil depths of the sea; arenaceous and argillaceous deposits prevailing in the lower, and cretaceous in the upper division of the series; periodical intrusions of heated fluids charged with silex having taken place at uncertain intervals. The fossils prove that the ocean

Pl. X.



CHALK CLIFFS NEAR FRESHWATER-GATE; LOOKING WESTWARD.

CHAPTER VII.

FROM YARMOUTH TO FRESHWATER-GATE—SCRATCHELL'S BAY—VERTICAL CHALK STRATA—SHATTERED FLINTS—THE CHALK DOWNS—CAUSES OF THE PRESENT CONFIGURATION OF THE CHALK HILLS—FROM FRESHWATER-GATE TO COMPTON BAY—GEOLOGICAL SECTIONS OF THE SOUTHERN COAST—PEBBLES AND SHINGLE.

FROM YARMOUTH TO FRESHWATER-GATE.—In resuming our survey of the geological phenomena of the Isle of Wight, we proceed from Yarmouth to Freshwater-gate, on the south-western shore. In a direct line, through the transverse valley of the river Yar, which rises from the northern foot of the downs, the distance but little exceeds two miles and a half; but the road makes a considerable detour to the left, round the eastern border of the estuary. Passing over a gently undulated country of the fluvio-marine eocene strata, and ascending a steep acclivity of tertiary sands, we cross the narrow tract of highly-inclined chalk which unites Afton-Downs on the east with High Down on the west, and reach the southern coast by an opening in the chalk cliffs that extend from Compton Bay to the Needles.

Immediately on our left are some detached pinnacles of chalk jutting into the sea, and on the right the fine section of highly-inclined strata of chalk and flint represented in Pl. X. At the base of this headland is the entrance to a considerable excavation in the cliff, produced by the erosive action of the waves on the lower beds of chalk; some perpendicular masses of the harder portions of the rock worn into irregular columns support this natural archway, which is known to tourists as "The Cave." It extends 120 feet into the cliff, and is between thirty and forty feet high;* it is well deserving the notice of the geologist, for the displacement the strata have undergone is here strikingly displayed.

From Freshwater-gate to the Needles, a distance of three miles, the cliffs present a succession of mural precipices of chalk from 400 to upwards of 600 feet in height. The face of these cliffs when seen from the sea at a short distance has a remarkable appearance, from the rows o flints, which score the surface of the white rock with fine dark parallel lines, running in an oblique direction from the top to the bottom of the section. In some places the lines are undulated, in others arched, and near the summit of the cliff towards Alum Bay, they are very flexuous, and bent down, as if a heavy mass above had pressed upon the upper ends of the layers of flints, while the chalk was in a plastic state. The general inclination of the beds of this part of the range is nearly vertical on the north, with a gradually decreasing angle towards the south.

SCRATCHELL'S BAY.—The most stupendous line of chalk cliffs is that termed the Main-bench; and beyond is Scratchell's Bay, which is bounded by the Needles. The aspect of the scene in this bay is romantic in the extreme. In the face of the cliff, from the destruction of the lower beds of the bent strata, a magnificent arch 300 feet high has been produced, and forms an alcove that overhangs the beach 150 feet.†

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* The description and beautiful illustrations of the picturesque features of the scenery along this part of the coast, in Sir H. Englefield's "Isle of Wight," render it unnecessary to dwell upon this inviting subject. Some of Mr. Bartlett's views of these chalk cliffs, in Barber's "Illustrations," are very accurate and effective.

† In calm weather Scratchell's Bay and the Needles may be safely visited in the pleasure-boats to be hired at Freshwater Gate; parties generally land on this strip of shingle to view the stupendous arch above. A splendid view of the bay, by Mr. Webster is given in Pl. 25, of Sir H. Englefield's work.

The well-known pinnacles of chalk called The Needles are isolated masses of the extreme western point of the middle range of Downs, which have been produced by the decomposition and wearing away of the rock in the direction of the joints or fissures, with which the strata are traversed. The angular or wedge-shaped form of these rocks, has resulted from the highly inclined northward dip of the beds of which they are composed.

VERTICAL CHALK STRATA.—To the late Sir Henry Englefield belongs the merit of having first observed and directed attention to the highly interesting phenomena, occasioned by the disruption and elevation of the eocene and cretaceous formations, which are so remarkably displayed in the Isle of Wight—namely, the vertical position of the strata, and the shattered condition of the flint nodules, though still imbedded in the solid rock. These appearances may be conveniently examined in the cliffs before us.

The chalk forms parallel beds or strata varying from two to five feet in thickness, which are commonly separated by layers of flint nodules imbedded at irregular distances from each other; there are also a few nodules dispersed indiscriminately in the mass. The dip of the inclined strata as previously stated is in general from 70° to 80°: but many beds throughout a considerable extent are quite vertical. (See Pl. XIII.) The parallelism of the cretaceous strata, and the absence of sand, gravel, and other coarse detritus, denote that the deposition of these calcareous sediments took place in tranquil water, and remote from sea-cliffs and shores. Where a large extent of the cliff is exposed, the face of the chalk is seen to be traversed by *fissures* or *joints* at right angles to the planes of stratification; some are vertical, others diagonal, and crossing in various directions, divide the entire mass into irregular portions; in some localities these partake of a rhomboidal form.* These fissures have evidently been produced after the consolidation of the strata in which they occur, for where they traverse the horizontal layers of flint nodules, some of the latter are often displaced: and very commonly a fault, or interruption of the parallelism of the opposite sides of the chasm has taken place, either from the elevation or the subsidence of one of the separated masses. In many instances the fissures are filled up with flint which occupies the crevice wholly, or partially, throughout its whole extent, forming large sheets of pure silex, varying in thickness from that of pasteboard to two or three inches. These siliceous veins often consist of two plates with loose calcareous detritus between them, as if the flint had flowed down or oozed from the sides of the fissures; and this detritus is frequently composed of shells of microscopic foraminifera. In other cases the cavities are filled with marly and soft chalk; and in many instances they are empty, but their sides are lined with crystallised carbonate of lime. These fissures are evidently referrable to a period long antecedent to the elevatory movements which broke up the chalk strata, and hurled them into their present position, for they traverse the horizontal layers; and the subsequent introduction of flint, proves that they were the effect of submarine movements, which took place while the physical condition of the bed of the cretaceous ocean remained unchanged. This fact also corroborates the inference, that the eruptions of steam or vapour charged with silex into the chalk, occurred periodically, and sometimes at long intervals.

But there are numerous chasms and fissures in the strata which clearly belong to a very different epoch; to a period geologically recent, when the now upper surface of the chalk was rent by earthquakes, and the mountain masses of the cretaceous system acquired their present position and configuration. For these fissures are invariably connected with the surface, and are more or less filled with clay, sand, gravel, and waterworn flints, from the alluvial debris that forms the subsoil of the country. These appearances may be observed in the chalk underlying the bed of gravel and clay, on which the Albion Hotel at Freshwater-gate is situated.

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* Mr. Webster particularises the large chalk-pit on the south side of Arreton Down near the top, not far from Ryde. In this quarry the strata are inclined at an angle of 80 deg.; and both the tabular flints and the nodules are completely shivered.

SHATTERED FLINTS.—Upon carefully extracting a flint nodule from this cliff it retains its original form; but upon examination it will be found "shattered in every direction and broken into pieces, varying in size from three inches in diameter down to the minutest fragment, and even into an impalpable powder. The flints thus shivered, as if by a blow of inconceivable force, retain their form and position in the bed. The chalk closely invests them on every side, and till removed, nothing different from other flints can be perceived, excepting fine lines indicating the fracture, as in broken glass; but when moved, they fall at once to pieces. The fragments are as sharp as possible, and quite irregular, being certainly not the effect of any peculiar crystallisation or internal arrangement of the material, but solely attributable to external violence." Such is the description of this remarkable phenomenon given by Sir H. Englefield thirty years since.* The tabular and plated flint in the fissures is also shattered in a similar manner. The nodules in the regular layers are invariably in this state, in every locality of the vertical and highly inclined chalk; but the separate nodules in the middle of the strata are entire; and in the horizontal beds, as, for example, on St. Catherine's, Boniface, and Shanklin Downs, all the flints are unbroken. This shattered condition of the flints has doubtless arisen, as Sir Henry Englefield suggested, from the concussion caused by the upheaval and disruption of the once horizontal cretaceous deposits. The disturbing force, though in many instances producing flexures in the strata, was clearly exerted violently and suddenly, and in such manner as to shatter the flints without dislodging them from the chalk. From the insulated nodules being generally entire, it would seem that the greatest violence of the shock was exerted in the direction of the lines of stratification.

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* Sir H. Englefield's "Isle of Wight," pp. 20, 21. The following places are enumerated as exhibiting this phenomenon very distinctly:—Alum Bay, Pit south of Carisbrook Castle, and near Carisbrook town, Arreton Pit, Brading-Down Pit, Brading Shute, Culver Cliff. Shattered flints are occasionally met with in some parts of the Sussex and Surrey chalk. My attention was first directed to the subject in 1820, by a paper of Sir H. Englefield, in the "Linnæan Transactions;" and a chalk-pit on the top of North Street, Brighton, now filled up, and the area built over, presented

Mr. Webster, in describing the shivered flints in the chalk at Handfast Point, on the Dorsetshire coast, remarks that the nodules are not only much shattered, but appear as if they had been reduced to atoms while the rock was yet *in a soft state,* for the fragments are in general separated from each other, with chalk between them; and the broken pieces of flint are at such distances, that it is impossible to conceive by what means they could have been so far separated, had the chalk been solid at the moment of their fracture. The bent condition of the strata at Handfast Point, which will be described in a future page, attests the plastic state of the chalk at the period when its upheaval took place.

THE CHALK DOWNS.—We now leave the sea-shore to ascend the hill, and proceed along the foot of Afton Down to Compton Bay, which is about a mile distant. The

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a fine example, for every flint, though retaining its form, was reduced to fragments. See the "Fossils of the South Downs," page 152.

western part of the central range of downs extends from the Needles Cliff to Motteston Down, which is 700 feet high, and is a narrow ridge nine miles in length, with steep declivities on each side; that on the north arises from the highly-inclined dip of the strata; that on the south is produced by the precipitous escarpment formed by the sudden termination of the cretaceous beds where they rise to the surface. The summits of this range command views of great extent and picturesque beauty, for both the northern and southern shores are distinctly visible.* From the Needles Down may be seen on the north Tollands, Colwell, and Yarmouth bays; and on the south, Freshwater and Compton bays, and the distant line of coast. The eastern portion of this chalk range, from Arreton Down to Culver Cliff, a distance of seven miles, is of the same character.†

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* A graphic description of the scenery from this range of hills is given by Sir H. Englefield, chap. iii. The view from Buccomb Down, looking over Carisbrook Castle and Newport in the vale beneath, is very splendid; that from Arreton Down is equally fine.

† The view from Ashey sea-mark, which is situated on this part of the chalk-hills between Arreton and Brading Down, is thus described by the Rev. Legh Richmond:—

"Southward the view is terminated by a long range of hills (Shanklin, Wroxall, and Appuldurcombe), at about six miles distant. They meet to the westward another chain of hills, of which the one whereon I sit forms a link, and the whole together nearly encompass a rich and fruitful valley, filled with corn-fields and pastures. Through this vale winds a small stream for many miles; here and there lesser eminences arise in the valley, some covered with wood, others with corn or grass, and a few with heath or fern. One of these hills is distinguished by a church (New Church) at the top, presenting a striking feature in the landscape. Villages, churches, country-seats, farm-houses, and cottages are scattered over part of the southern valley. In this direction also appears an ancient mansion (Knighton), embellished with woods, groves, and gardens. South-eastward is a broad expanse of ocean, bounded only by the horizon. More to the

Ascending Afton Down, the summit of which is crowned with a group of tumuli, the views along the southern coast are lovely in the extreme. When almost half way up the acclivity, the landscape to the west displays a magnificent *coup d'œil* of the romantic scenery of Freshwater and Scratchell's Bays, and the Needles; and that to the east affords a view of Compton Bay, Brook Bay, and the coast, till it is lost in the remote distance.

CAUSE OF THE CONFIGURATION OF CHALK DOWNS.—From what has been stated as to the composition of the white chalk, and the formation of the strata, the cause of the external configuration of the verdant downs we are now traversing appears sufficiently obvious. If we examine the spots where the turf has been removed by the flint-diggers, we perceive immediately beneath the vegetable mould a thick layer of loose nodules but slightly abraded, and in no instance worn into the state of boulders, pebbles,

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east, in continuation of the chain of hills on which I am sitting (Ashey), rise two downs (Brading and Yaverland hills), one beyond the other; both are covered with sheep, and the sea is just visible over the furthest hill, as a terminating boundary. In this point are seen ships, some of which are sailing, and others lying at anchor. On the north, the sea appears like a noble river (the Solent), varying from three to seven miles in breadth, between the banks of the opposite coast and those of the island. Immediately underneath me is a fine woody district, diversified by many pleasing objects. Distant towns (Portsmouth and Gosport) are visible on the opposite coast; and numbers of ships occupy the sheltered station which this northern channel affords them. Westward, the hills follow each other, forming several intermediate and partial valleys, in undulations like the waves of the sea, and bending to the south, complete the boundary of the larger valley I have described, to the southward of the hill on which I sit. One hill alone (St. Catherine's), the highest in elevation, and about ten miles to the south-westward, is enveloped in a cloud, which just permits a dim and hazy sight of a signal-post, a light-house, and an ancient chantry, on its summit."—*Annals of the Poor, by the late Rev. Legh Richmond.*

or gravel. The surface of the chalk covered by the flints is furrowed and waterworn, like that of the exposed chalk along the coast. From the state of the loose flints it is evident that, although they must have been washed out of pre-existing strata, they have not been subjected to the action of the waves for any considerable period, like the materials of the existing sea-beach. For when masses of the chalk cliffs fall within reach of the billows, the exposed portions of the flints are completely rounded before the nodules are loosened and detached from the parent rock; and so soon as the flints are liberated by the wearing away of the surrounding chalk, they are quickly driven against each other and broken, and the fragments ground into pebbles, gravel, &c. In this manner are formed the shingle and sands that accumulate along the sea-shore.

From the state of the down-flints, it is therefore obvious that the deposits whence they were derived must have been less consolidated than the present chalk, and have admitted of the removal of the calcareous materials, and the consequent extrication of the siliceous nodules from the rock, in a comparatively short space of time; and the disengaged flints, after a very brief exposure to attrition, must have been transported beyond the reach of the waves.

From the organic composition of the chalk (*ante*, p. 130), it is manifest that when first deposited at the bottom of the ocean, it was a fine white detritus or mud, resembling in its nature and appearance the chalk now in progress of formation along the coasts of the Bermuda islands;* some layers of which are as rich in microscopic shells as any of the cretaceous strata. The veins and beds of flint, as we have previously explained, probably originated from the periodical introduction of thermal waters highly charged with silica into the calcareous sediment. The subsequent conversion of the incoherent

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* "Wonders of Geology," vol. i. p. 69.

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ASTOR, LENOX AND
TILDEN FOUNDATIONS.

Afton Down. The pedestrian should take the path along the edge of the cliff to Compton Chine, where a narrow track leads to the sea-shore. As we approach this spot, a fine view is obtained of the line of coast from the bay to beyond Brook Point, as is shown in the slight sketch, Pl. XI. The foreground is part of the southern slope of Afton Down, consisting of flinty chalk; and the foot-track to the Chine is seen crossing it on the right. The cliffs in this view are composed of the clays, shales, and sands of the Wealden, which continue to near Atherfield Point. The nearest headland is Brook Point, the western boundary of Brook Bay; and the one immediately beyond is the eastern limit of the same. The ledges of rock, extending from the foot of Brook Point into the sea, are chiefly composed of petrified trees. The most distant cape is part of the greensand cliffs, near Blackgang Chine; and the lofty range on the horizon is St. Catherine's Hill.

Compton Chine is a deep chasm worn in the ferruginous sands by a stream that falls from the summit of the cliff. It is situated to the west of the Blockade-station.

The footpath to the shore slopes along the face of the crumbling cliffs of greensand strata, which rise from beneath the upper divisions of the cretaceous system, as is shown in lign. 16. The succession of the beds from Freshwater to Compton Bay, *i. e.*, from west to east, is as follows:—

1. Upper or flinty chalk.
2. Lower chalk.
3. Firestone, comprising the chalk marl.
4. Galt.
5. Greensand, consisting of beds of ferruginous sands, clays, sandstones, and layers of very compact ironstone grit.
6. Wealden clays, sands, shales, and limestones.

GEOLOGICAL SECTIONS OF THE SOUTHERN COAST.—The strata incline to the west, as is shown in lign. 16, to beyond Brook Chine, where the eastern side of the anti-

[illegible]

[illegible] in the shingle at Cam[illegible] [illegible] have [illegible] been washed out of the Wealden strata, or [illegible] identical in mineralogical character occur in the grits of Tilgate Forest and Tunbridge Wells.

But the shingle contains other siliceous pebbles which essentially differ from those of the chalk-flints. Some of these are composed of a dark-brown mottled jasper, and when cut and polished resemble the well-known Egyptian pebbles: others are of an opaque white jasper, veined with black dendritical or arborescent figures, or marked with zones of rich brown tints. Some have a concentric arrangement of bands of silex of various shades of colour, and

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* Not the *German* moss-agates exhibited in the shops as the genuine productions of the Island. See note to page 2.

† "Thoughts on a Pebble," pl. 1 and 2.

resemble agates; others assume the character of botroidal and mammillated chalcedony.

The differences observable in the materials composing the shingle, did not escape the notice of Mr. Webster, who describes some of the principal varieties of the pebbles, and suggests that those which are not waterworn chalk-flints may have been derived from veins or nodular masses of silex, in tertiary strata now destroyed. A polished slice of silicified wood found in the shingle of Sandown Bay, was presented to me by Mr. Fowlstone, of Ryde.

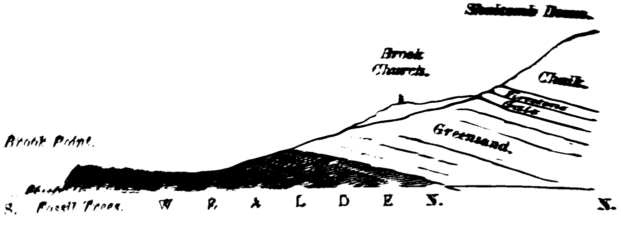
I believe specimens of this kind are very rare in the Island; but on the western coast of Sussex waterworn fragments of silicified monocotyledonous wood are occasionally met with.

Boulders and pebbles of petrified bone and wood, and of shelly limestone, are common on the beach in Compton and Sandown Bays; they are from the Wealden beds, and will be more particularly noticed in a subsequent chapter.

CHAPTER VIII.

FROM COMPTON BAY TO ATHERFIELD POINT—ATHERFIELD CLIFFS—GREENSAND SERIES—SECTIONS OF ATHERFIELD STRATA—GREENSAND FOSSILS—CLIFFS AT BLACKGANG CHINE—THE UNDERCLIFF—GEOLOGICAL STRUCTURE OF THE UNDERCLIFF—FOSSILS OF THE FIRESTONE—SOUTHERN RANGE OF CHALK DOWNS—COAST OF THE UNDERCLIFF—FROM VENTNOR TO SANDOWN BAY.

FROM COMPTON BAY TO ATHERFIELD POINT.—The road from Compton Chine to the coast-guard station at Atherfield Point runs along the southern flank of Shalcomb and Mottestone Downs. As we pass Brook Manor-house the ferruginous beds of greensand may be traced in the banks on the road-side; and Brook church is seen standing high up the hill on a terrace of those deposits. The relative positions of the strata in this district are displayed in the cuttings on the sides of the road from Shalcomb Down through the village of Brook to the sea-shore; as shown in



LIGN. 18.—SECTION FROM BROOK-POINT TO SHALCOMB-DOWN; 1½ MILE.

lign. 18. If we proceed from the coast at Brook Chine the village, and ascend the road by the church, and over Shalcomb Down, we pass in succession, 1, the Wealden; 2, the Greensand; 3, the Galt; 4, the Firestone; and then cross the ridge formed by the highly-inclined strata of the White-chalk.

The turnpike-road leads through the villages of Mottestone* and Brixton to Shorwell, where it divides, and sends off a branch to Newport on the north-east, and another on the south-east, through Kingston and Chale to Blackgang Chine. About midway between Brixton and Shorwell a tenantry road turns off to the right, and admits a carriage to within a few hundred yards of the cliff, near the Atherfield coast-guard station. This is the most convenient place to alight, and reach the sea-shore near the junction of the greensand and Wealden formations. The path down the precipitous face of the cliff lies a little to the east of the station; it is a mere foot-track worn in the rock by the sailors and fishermen.† At a moderate distance westward of the spot where the path reaches the shore, is the headland called Atherfield Point, on which stands the station-house; and at its foot a ledge of rocks extends into the sea. Near this place, after recent slips of the cliff, and the removal of the fallen debris by the waves, the uppermost of the wealden deposits, and the lowermost of the greensand may be seen in juxta-position; in other words, the line of demarcation between the accumulated sediments of a mighty river—some primeval Nile or Ganges, two or three inches above there is a stratum of sandy clay containing marine shells. The distance between the layers of fluviatile and marine shells is therefore but a few inches; so that, as Dr. Fitton remarks, portable masses containing characteristic shells of both formations may be extracted. I have not been so fortunate as to visit Atherfield Point when the line of junction at the base of the cliff, and to the westward, was exposed to any considerable extent. But sometimes, from a conjunction of favourable circumstances, the strata are laid bare for several hundred yards. This happens after heavy gales and high tides, which sweep away both the fallen masses of rock and the sea-beach, and expose a large surface of the adjacent strata washed clean, and visible at low water.*

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* On an eminence overlooking the village of Mottestone is a rude pillar of ferruginous sandstone called the "Long-stone," and which was probably erected as a landmark or boundary stone, at a very remote period. It is twelve feet high, and of an irregular quadrangular form.

† This path is too precipitous and inconvenient to be attempted without risk by ladies or invalids. I have always visited the spot by this route, and am not aware of there being a more easy descent to the beach, except at a long distance from the most interesting part of the cliffs.

1. *Lowest Greensand Clay.*†—A bed of brown clay with marine shells; three feet thick. In the lowermost layers, near the Wealden shale and clay, are seams of minute fish-bones.
2. *Perna Mulleti Band.*—A stratum two feet thick, of a very firm sand-rock, characterised by numerous shells, and especially by a layer of the *Perna mulleti* (Pl. IV. fig. 6), which also occurs in the same relative stratigraphical position in Compton and Sandown Bays.
3. *Lower Lobster Clay-bed.*—Clay strata, with numerous fossils in the lower, and but few in the middle beds. The upper layers are remarkable for the abundance of a small species of lobster (*Astacus*), which occurs in a beautiful state of perfection, imbedded in blue saponaceous clay approaching to fuller's earth. The specimen figured in the vignette of the title-page of this work is from this stratum. Total thickness 100 feet.
4. *The Cracker's Rock.*‡—Sandy clay, with two bands of nodular

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* Such was the state of the cliff when visited by Dr. Fitton in 1843. "Proc. Geol. Soc." vol. iv. part 1.

† The names adopted are those employed by Captain Ibbetson and Professor E. Forbes. "Geol. Journal," vol. i. p. 190.

‡ This local name is said to be derived from the noise made by the breakers when dashing over the rocks and ledges of this con- ary sand-rock.

or concretionary masses of very hard calciferous sandstone; eighteen feet. These beds are highly interesting for the abundance and variety of their organic remains. The nodules consist of very compact rock, and contain innumerable shells in a perfect state, of which many species do not occur in any other strata. The *Gervillia anceps* (Pl. IV. fig. 3) is crowded together in groups of hundreds, and the shells are as perfect as if lying in their native bed. Several small shells from the Cracker's rock are figured in Pl. V. (figs. 4, 6, 7, 8, 9, 10). These fossils occur in such numbers and variety, that almost every considerable fragment of the rock will be found to contain several species.

5. *Upper Lobster Clay.*—A deposit of saponaceous clay, similar to No. 3, and abounding in the same kind of fossil lobsters as that bed. It also contains ammonites and other shells; total thickness twenty feet.
6. *Zone of Terebratulæ.*—Clays full of fossils, twenty feet; above which is a bed of dark sand, twenty-two feet in thickness, enclosing immense numbers of *Terebratulæ* (Pl. V. fig. 5), and *Serpulæ.*
7. *Zones of Gryphеæ and Scaphites.*—A series of sands and clays, including layers of *Gryphеæ* (the large bivalve figured in Pl. V. fig. 3), imbedded in dark sand, and alternating with bands of nodules which contain gigantic *Scaphites* (Pl. V. fig. 11), ammonites, and numerous other fossils; total thickness, 155 feet.
8. *Upper zone of Terebratulæ.*—A bed of sand, thirty feet thick, full of layers of Terebratulæ (chiefly of *Terebratula biplicata*); above which is a stratum of dark sand, twenty-four feet thick, with a band of Gryphеæ as in No. 7, but without the Scaphite nodules.
9. *Ferruginous Sands.*—Sands highly ferruginous, with layers of dark-blue clay, and bands of ironstone nodules full of casts of shells (Pl. IV. fig. 7, Pl. V. fig. 1), of the genera Venus, Thetis, Trigonia, &c. Seams of lignite are disseminated through the lower beds in undulated laminæ; and thin layers of ironstone grit without fossils occur in the upper part of the series. The beds in contact with the galt are generally of this character.

In the upper 250 feet of the greensand but few organic remains are met with, and the strata are more or less highly

[illegible]

NEOCOMIEN, OR ATHERFIELD STRATA.—The inf [illegible] greensand at Atherfield, from the lowest be [illegible] inclusive, abounds in fossils which are e [illegible] altogether absent in the upper part of [illegible]. A group of subcretaceous deposits near Neufch [illegible] Switzerland, having lately been found to contain m [illegible] species of shells not previously known in other parts of [illegible] cretaceous system, has, in consequence, been describe [illegible] eminent French geologists as a distinct format [illegible] belonging to a period antecedent to the deposition of [illegible] greensand, and synchronous with the Wealden; and t [illegible] designated the group *Terrain Neocomien.*

Dr. Fitton has shown, by a careful comparison of a l [illegible] number of the French fossils with those from Atherfi [illegible] that so close an agreement exists in the organic remain [illegible] to leave no reasonable doubt that the so-called Neocon [illegible] are but the equivalents of the lower series of [illegible] English greensand system.†

In a Report read before the British Association [illegible] Science at Southampton,‡ Dr. Fitton gave a table of [illegible] species of shells, the stratigraphical position of which [illegible] been accurately determined. From this it appears t that in the upper beds, comprising a thickness of nearly 700 feet, but twenty additional species are met with; the absolute number of fossils also rapidly diminishes, but few, if any, organic remains appearing in the uppermost layers. But throughout this period of consecutive deposition, one series of fossils only is indicated, bounded by the Wealden below and the galt above. It is the lowermost part of the Atherfield section which is regarded as the equivalent of the remarkable fossiliferous group of Neufchatel. The principal difference between the continental and English greensand fauna, is stated by Professor E. Forbes to consist in the abundance of gasteropoda and cephalopoda in the former, and of acephalous bivalves in the latter.

GREENSAND FOSSILS.*—The organic remains of the greensand to be met with along this coast are almost exclusively shells; but few traces of the higher orders of animals, or of plants, have hitherto been observed. It should, however, be borne in mind, that remains of land reptiles, and trees, and plants, have been found in strata of this formation in Kent; similar relics may therefore occur in the same deposits in the Isle of Wight.†

Of the vegetable kingdom but few vestiges have been discovered. The laminæ of lignite in the upper ferruginous beds, and obscure traces of fuci in some of the lower sandstones, are the only indications of the flora of this geological epoch that have come under my notice. But remains of the foliage of a fern that abounds in the

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* The finest collection of the organic remains of the greensand of the Isle of Wight is, I believe, that made by Captain Ibbetson, and now exhibited in the Polytechnic Institution of London. The Geological Society has the most complete series of the shells, principally contributed by Dr. Fitton, and named by Professor Forbes. Figures of most of the species will be found in "Mineral Conchology," Dr. Fitton's "Memoir," and in the "Geological Journal," vol. i.

† See "Wonders of Geology," vol. i. p. 394.

Wealden (*Lonchopteris Mantelli*, lign. 22) were discovered by Mr. Morris in many of the strata at Atherfield; and the Messrs. Gladstone have since found several leaflets of the same species associated with trigoniæ, &c., in ironstone nodules at the foot of Shanklin Cliff. This interesting fact we shall have occasion to notice in a subsequent chapter. Of the poriferæ and corals but few species occur. Traces of bulbiform *siphoniæ* (apparently *S. pyriformis*, Dr. *Fitton's* "Memoir," Pl. XV.) are sometimes displayed on the waterworn surface of fallen blocks of sandstone. A small elegant coral, a species of *astræa*, is not uncommon in the *Cracker's* Rock at Atherfield.

The lowermost beds at Atherfield Point being very *fossiliferous*, the collector will have but little trouble in *obtaining good specimens* of the shells distributed in these *strata*; the *perna mulleti* (Pl. IV. fig. 6) may generally be *extracted tolerably perfect*.* From the nodular masses of the *Crackers*, with which the shore at low water is often *thickly strewn*, an abundance and variety of shells may be *procured*; and that part of the cliff where the two parallel layers of these concretionary masses are within reach (almost half a mile to the east of Atherfield Point), will afford specimens at all times. The large *gryphea sinuata* (Pl. V. fig. 3) may be found everywhere along the shore; the shell being sufficiently strong to resist for a time the action of the waves, clean and perfect examples often occur imbedded in the sand. Beneath Walpen High-cliff, and at Whale's Chine, the gryphea bed may be examined *in situ*; the *terebratula sella* (Pl. V. fig. 5) may be obtained from the loose green sand (No. 6, p. 165) in great perfection and variety.

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* It is necessary that the geologist should so arrange the time of his visit to this coast as to arrive at Atherfield at the beginning of the ebb of the tide, that he may be able to examine the cliffs and p[illegible]imens at leisure.

The magnificent cephalopodous shell, the *Scaphites grandis*[*] (*S. gigas* of our Pl. V. fig. 11), is most likely to be met with near the base of the same part of the cliffs. Some fine specimens have been found along the shore near Ladder Chine; and very large ammonites and nautili occur in the same locality. On the shore, not far from the base of Blackgang Chine, nodules with scaphites may be observed above a bed of sand full of terebratulæ.

The fossil lobsters, the most beautiful of the Atherfield fossils, may generally be met with after recent slips of the cliff involving masses of the strata (Nos. 3 and 5, p. 164, 165), in which they occur. The vignette of this volume (engraved by Mr. Lee from a drawing by Mr. J. Dinkel) represents an exquisite specimen from a fallen block lying near the pathway at the foot of Atherfield Cliff.

Minute bones of fishes in the lowermost clay, and a few teeth of the *shark* family, are the only remains of vertebrate animals I have observed; but Captain Ibbetson has obtained from these cliffs a specimen of extraordinary interest. It is a considerable portion of the skull, with the bones of the face and the jaws and teeth attached, of a species of *hybodus;* a genus of fishes of the shark tribe, having teeth of a transversely elongated form, with a series of compressed conical cusps, of which the middle one is the longest.[†]

In this remarkable fossil the mouth is open, and forms a semilunar aperture six inches wide. The upper jaw has twenty-four teeth, and the lower nineteen, in their natural position; two rows of successional teeth are traceable behind the anterior series. These teeth, as shown in lign. 10, have a central cusp rather hooked, and two lesser points on each side.

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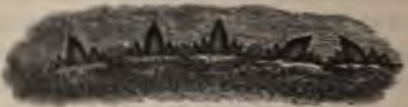
[*] The shell has been described under different names, as Crioceras Bowerbanksii, Scaphites gigas, &c.; the latter name is given in the description of Pl. V., but Professor E. Forbes has adopted that originally affixed to this gigantic cephalopod by Mr. Sowerby. *Scaphites* are distinguished from *ammonites* by the disunion of the whorls, and from *hamites,* by the spiral arrangement of the posterior volutions. A very small species of scaphite (not exceeding an inch in length) is frequent in the chalk marl. See "Medals of Creation," vol. ii., for an account of fossil *Cephalopoda.*

[†] "Medals of Creation," vol. ii. p. 622.



LIGN. 10.—FIVE TEETH ATTACHED TO A PORTION OF THE JAW OF A FISH OF THE SHARK FAMILY; FROM ATHERFIELD.

(*Hybodus basanus, of Sir P. Egerton.* "Geol. Journal," vol. i. pl. iv.)

The *hybodonts*, like other fishes of this family, were armed with strong dorsal spines, which are often found in the lias, oolite, and Wealden strata; and, rarely, in the chalk.*

THE CLIFFS AT BLACKGANG CHINE.—Proceeding from Atherfield Cliffs eastward, the first interesting point is Blackgang Chine; a spot well known to every tourist who visits the Undercliff. Viewed from the sea-shore at low water, especially when the springs which feed the waterfall have been swollen by heavy rains, the effect is highly picturesque. The cascade falls in a perpendicular column from a ledge 70 feet high, down the midst of a deep chasm formed in dark ferruginous clays and sands, and surmounted by broken cliffs 400 feet high; and towering above all is the majestic escarpment of Saint Cathe-

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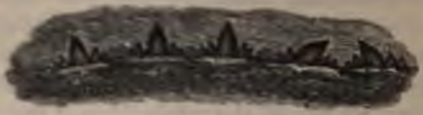
* [illegible] Egerton's specimen is in the Polytechnic Institution [illegible] at the entrance of the Isle of Wight model-room. [illegible] and described by Sir Philip Egerton in "Geol. [illegible] 197. Unfortunately, the drawing was made [illegible] the face and jaws were cleared of the adherent [illegible] represents only the margin of the jaws with [illegible] filled by a shapeless mass.

a semilunar aperture six inches wide. The upper jaw has twenty-four teeth, and the lower nineteen, in their natural position; two rows of successional teeth are traceable behind the anterior series. These teeth, as shown in lign. 19, have a central cusp rather hooked, and two lesser points on each side.



LIGN. 19.—FIVE TEETH ATTACHED TO A PORTION OF THE JAW OF A FISH OF THE SHARK FAMILY; FROM ATHERFIELD.

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* Capt. Ibbetson's specimen is in the Polytechnic [illegible] on a pedestal at the entrance of the Isle of W[illegible] It is figured and described by Sir Philip [illegible]

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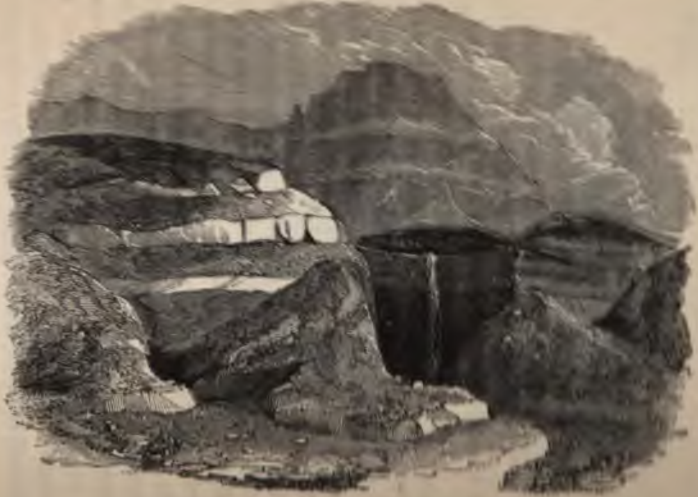
Pl. XII.



BLACKGANG CHINE. FROM THE SEA-SHORE

rine's Hill, rising to an altitude of between eight and nine hundred feet. The sketch in Pl. XII. shows the section exhibited in the face of the cliffs. The bands of greenish-grey sand and sandstone which alternate with ferruginous clays in this division of the greensand system, appear very prominent, owing to the wearing away of the soft and friable intermediate beds.

As the face of the sandstone, after long exposure to the atmosphere, separates into square blocks, the appearance of the projecting bands of stone, which are from ten to fifteen feet thick, is very singular, and is not unaptly compared by Sir H. Englefield to courses of masonry built up at different heights to sustain the mouldering cliffs. The thin layer of ironstone grit which, as we have previously remarked, is very constantly found in this division of the greensand, constituting as it were a line of demarcation between the upper arenaceous deposits and the lower more argillaceous group, intercepts the water that percolates through the upper porous strata, and projecting in a ledge forms the bed of the stream that falls in a cascade over the face of the cliff.

In reference to the springs along this coast it may here be remarked, that no less than ten copious streams issue from the strata on the south side of the range of hills facing the Undercliff, and run directly into the sea; most of those which flow from the greensand are chalybeate. At Sandrock, near Bla•kgang, is a celebrated aluminous chalybeate spring, of which an analysis was published by Dr. Marcet in "Geol. Trans." vol. i. This water is highly charged with sulphate of iron and alumina. It rises from a bed of sand within fifty feet of the galt.

THE UNDERCLIFF.—We have now arrived at the western extremity of that interesting and picturesque region known as the Undercliff of the Isle of Wight; and which may be described geologically as a miscellaneous accumulation of debris, principally composed of fallen masses of the upper cretaceous strata, occasioned by the encroachments of the sea on the lower argillaceous and sandy deposits that form the base of this line of coast. The Undercliff consists of an irregular terrace, sloping towards the south, from a quarter to half a mile in breadth, and six miles in length; its elevation above the sea is from 100 to 400 feet. It is protected on the north by the escarpment of the southern chain of hills, which forms a line of vertical cliffs, from 200 to 400 feet high, and extends from St. Catherine's to Shanklin Down.

There is perhaps no tract of such limited extent that affords so remarkable an instance of the modification of climate induced by geological structure and physical configuration as the Undercliff. Completely sheltered on the north by the range of chalk cliffs—elevated above the influence of the mists and fogs of the sea-shore—possessing a soil composed of the detritus of chalk and sandstone, which rapidly absorbs and carries off superfluous moisture, yet supports a luxuriant vegetation—with an undulated and varied surface enjoying throughout its whole extent a southern aspect—and fanned only by breezes which invigorate but do not chill—this fairy region well merits the high encomium of the medical philosopher. It is, indeed, what Sir James Clark, in his invaluable work on Climate, has described it to be—"a lofty natural terrace backed by a mountainous wall on the north, and open on the south to the full influence of the sun from his rising to his going down, during that season when his influence is most wanted in a northern country. The climate is remarkably equable as well as mild and dry, and there are not many days during the winter on which the invalid cannot take some exercise in the open air. The mildness and dryness of the climate [illegible] the winter months may be in some degree [illegible] circumstance of myrtles, geraniums, and various tender greenhouse plants usually withstanding the winter in the open flower-borders. The absorption of heat by the almost perpendicular cliffs of the Undercliff, exposed as they are to the rays of the sun during the whole day, must be considerable, even in winter: and the radiation of this heat during the night no doubt tends to equalize the temperature. To the invalid who has a taste for natural history, this sheltered district and neighbourhood possesses an additional advantage. It is rich in varied and interesting plants: indeed, the specimens of natural history with which it abounds offer abundant inducements to exercise, and healthful mental occupation, to the cultivators of this delightful science."* How great will be my reward, should these humble pages open a new source of intellectual enjoyment to any of those who may repair to this favoured spot, for the restoration of health, or the alleviation of mental affliction.

GEOLOGICAL STRUCTURE OF THE UNDERCLIFF.—The structure of this district will be readily understood by an examination of the western extremity of the Undercliff. The diagram, lign. 17 (p. 157), illustrates the position of the several groups of the cretaceous beds at St. Catherine's Down, which is 830 feet in height; the strata are nearly horizontal. The greensand series reaches to the top of the cliff at Blackgang, upwards of 400 feet high; the galt lies above it, and forms a bed more than 100 feet thick. The marls, sands, and calcareous sandstones, comprised under the name of firestone, in thickness about 100 feet, next appear, and rise into a vertical inland cliff, half a mile from the shore. Strata of white chalk form the summit of St. Catherine's Down, the total thickness amounting, in some places, to 250 feet; but on the south-western brow of the hill these beds thin out, and form a mere capping over the firestone.*

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* "The Sanative Influence of Climate," by Sir James Clark, Bart., M.D., &c. Fourth edition. London, 1846.

The galt is seen at the top of the ravine west of Blackgang Hotel, resting upon the greensand which extends in a terrace beyond it. Some of the fossils peculiar to this deposit (*Inoceramus sulcatus*, and *I. concentricus*) have been obtained from this place. This bed also appears beneath the firestone on the face of the cliff east of the Chalybeate spring, above the road leading to Ventnor.

The firestone in the southern face of St. Catherine's hill, above the road from Niton, presents the usual characters of this group as they appear in a succession of terraces along the Undercliff.† The chalk-marl forms the upper part of the series, and passes downwards into greenish grey sands and calcareous strata, in which are layers of bluish marl rock. Strata of cherty sandstone, alternating with layers of sandy marl, occur in the lower part: and from the disintegration and removal of the intermediate earthy beds, the chert appears in projecting ledges along the face of the southern escarpment of the downs, through a considerable extent of the Undercliff. This circumstance imparts a peculiar feature to the landscape, and, under certain combinations of rock and vegetation, contributes greatly to the picturesque character of the local scenery.‡

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* Mr. Lowry, the eminent engraver, informs me that the firestone reaches to within 133 feet of the beacon on St. Catherine's Down, as he ascertained by barometrical observation in 1837.

† The firestone strata in the Isle of Wight are more numerous and diversified than in Kent and the south-east of Sussex, and resemble the equivalent deposits in the western district of Sussex and Hampshire, so ably elucidated by Sir Roderick Murchison, in his first contribution to that department of natural philosophy, the boundaries of which his genius and important researches have since so largely contributed to extend.—See "Geol. Trans." vol. ii. Second series, 1828.

‡ Captain Ibbetson, whose beautiful and accurate models of the Undercliff are exhibited in the Polytechnic Institution, sub-

The layers and concretionary masses of chert are principally distributed in the upper part of the series; and beneath them are sands, and a bed of sandstone from two to four feet thick, which, though soft when first extracted, hardens by exposure to the air, and becomes an excellent building material. The ancient churches on the south side of the Island have been constructed of this stone, and it is being largely quarried for the edifices now in progress of erection.

Fossils of the Firestone Strata.—The fossils of the arenaceous and cherty strata of the firestone group comprise many species which also occur in the uppermost deposit, the chalk marl; and likewise several that have either not been observed, or are very rare in the other strata. They consist of several kinds of ammonites, nautili, hamites, scaphites, and other cephalopoda; numerous bivalves, especially pectens, terebratulæ, trigoniæ, &c., and of a few genera of simple univalves, as *cirrus*, *trochus*, *avellana*, &c. The bare enumeration of the species would occupy a considerable space, and be unintelligible, except to the scientific reader, without the aid of figures.

There is, however, one fossil which it is necessary to describe, from the abundance of its remains which meet the eye in almost every block of firestone. It is a species of *siphonia* (*S. Websteri*), a zoophyte resembling the sponge in its porous structure, but possessing numerous tubular channels that permeate the general mass, and communicate

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divides the firestone group into the following:—1, Upper greensand; 2, Chloritic marl; 3, Second bed of greensand; 4, Fossiliferous marl, in which large scaphites occur; 5, Two alternations of malm and rag: the term *malm* is applied to a firm argillaceous rock, and *rag* to the cherty sandstone that alternates with the former. A very large collection, comprising numerous species of shells, zoophytes, &c., has been obtained from these strata, and especially from the fossiliferous marl.

by openings into a central cavity.* This species is in the form of an oblong bulb with a shallow opening, supported upon a long slender stem, having a root-like base by which the original was attached to the rock. This fossil was first figured and described by Mr. Webster, under the name of *tulip alcyonium*. The bulbs and stems are often disposed in relief on blocks that have been weathered, or washed by the sea; for the fossils, being harder than the surrounding stone, more effectually resist abrasion, and large surfaces of firestone are therefore covered with their remains, which, being whiter than the rock, are very conspicuous.

FOSSIL CYCADEOUS PLANT.—But the fossiliferous marl (as Captain Ibbetson designates the bed most prolific in organic remains) has lately been found to contain relics of a higher order than any previously known to occur in the cretaceous strata of the Isle of Wight. In the collection deposited in the Polytechnic Institution, there is a specimen from the marl near Ventnor, that several years ago attracted my attention, but which I was unable to obtain an opportunity of examining till a few weeks since, when Captain Ibbetson, with great liberality, permitted me to inspect and figure it for this work. It proved to be, as I had conjectured, the summit of a stem, surrounded by the petioles, or leaf stalks, the leaves themselves having either been shed or decayed, of the *Clathraria Lyellii*, a cycadeous plant, hitherto only known in the Wealden formation. A figure (lign. 23) and description of this most interesting relic, will be given in the account of the organic remains of the Wealden in Chap. X.

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* "Mr. Webster on some new varieties of Fossil Alcyonia."—"Geol. Trans." vol. ii. First series, p. 376. Mr. Webster mentions that the first specimens, showing the connection of the stems and bulbous part, were observed on some "stupendous and difficultly-accessible masses of rock lying under the romantic cliffs of Western-lines." The branches vary in size from half an inch to three inches in diameter, and from six to eighteen inches in length; they terminate above in a bulb or head, somewhat resembling in form a closed tulip, and from one to six inches long; the other extremity branches into root-like fibres, by which these bodies, when living, were attached to rocks or stones. If the stems and bulbs are broken transversely, they are found to consist of bundles of longitudinal tubes; and this internal structure is generally silicified, so that polished sections are very interesting. I need scarcely remind the reader that these bodies have no relation to the alcyonia, which are polypiferous zoophytes; whereas these fossils are simply a congeries of tubes and pores, like certain sponges. The fossil that is figured in my "Medals of Creation" (vol. i. p. 259) as *Siphonia Websteri*, is not that species, but *S. pyriformis* of Goldfuss, which generally occurs in the greensand, but is occasionally met with in the firestone, and in the grey chalk, associated with another c[illegible] sponge, the *Scyphia meandrina*.

Fossil Femur of a Reptile. (?)—Another discovery, not less important, has recently been made in the easternmost quarry, above Bonchurch, and was communicated to me by S. M. Saxby, Esq., of Bellevue House, Ventnor; a gentleman to whom I am indebted for many interesting local details relating to the strata and fossils of the Undercliff. The specimen referred to is either the *humerus* (arm-bone) or *femur* (thigh-bone) of a terrestrial animal, probably of a gigantic lizard. It is broken transversely, and some two or three inches of the middle portion of the shaft are missing, but the articulating extremities are in excellent preservation. So far as a hasty inspection would enable me to form a conjecture of the affinity of this bone to recent types, it appears to approach nearest to the femur of the Monitor or Iguana; most certainly it bears no resemblance to the corresponding bone of any of the Wealden reptiles that have come under my notice. The lower portion is 9 inches in length, and terminates at its distal extremity in two large laterally compressed condyles, having a very wide *popliteal* space between them; the anterior or *patellar* aspect is smooth, and but little depressed. The transverse diameter of the bone at the condyles is 6½ inches; the digression on the zoological characters of the middle system of the chalk formation, we resume our geological survey of the southern coast. Before we climb St. Catherine's Hill, let the observer for a moment take another glance at the view commanded by the terrace in front of the Blackgang hotel, which affords a *coup d'œil* of the south-western shores. Looking down the ravine immediately at our feet, the aspect of the scene is singularly wild and dreary, from the sombre colours and fantastic masses of the broken walls of the chine, and the gloomy shade thrown athwart the chasm by the projecting cliffs. On the coast, the greensand strata are seen stretching on to Atherfield Point; and beyond may be distinguished Brook Point, which from this elevated spot appears as a low promontory; and farther west are the chalk cliffs, gradually vanishing away towards the Needles.

Ascending St. Catherine's Hill, a magnificent panoramic view bursts upon the sight. From the summit, a height of between eight and nine hundred feet, when the atmosphere is clear, the eye commands at one glance the grand features of the physical geography of the Island, and the range and extent of the principal groups of strata. We are now on the western extremity of the southern range of chalk downs, which, as previously explained (*ante*, p. 129), is separated by a considerable district of greensand from the central chain of hills.* This system of chalk downs varies in breadth from half a mile to three miles, and extends six miles in a direction E.N.E. and W.S.W. from St. Catherine's Hill to Dunnose, its eastern termination, which is nearly 800 feet high. The intermediate parts of the range maintain an elevation of from 650 to 800 feet, with the exception of a deep valley on the east of St. Catherine's, through which the road to Niton passes; and another at Steephill, called the Shute or Shoot, above

* Refer to the diagram, Pl. VII., and the map, Pl. XX.

Ventnor, traversed by the road to Appuldurcombe and Newport. A marl bank on the side of the Shute abounds in fossils.*

The strata of these hills are nearly horizontal, having only a slight inclination to the south-east. From Ventnor to St. Boniface Down, above Bonchurch,† a distance of three-quarters of a mile, the usual smooth verdant character of the chalk is resumed, and the hills rise to the height of 800 feet, sending off to the northward the lofty range of Shanklin Down, and terminating in Dunnose Point.‡ The

* Mr. Saxby informs me that he has obtained from this locality turrilites, ammonites, nautili, belemnites, and many other marl fossils.

† High up on the slope of the hill bursts forth a spring called St. Boniface's Well, to which local legends have attached much veneration.

‡ DEVIATION OF THE PLUMB-LINE AT SHANKLIN DOWN.—During the progress of the Ordnance survey, a deviation of the plumb-line from its mean direction was observed in the neighbourhood of Shanklin Down, by Col. Colby, the Director of the Trigonometrical Survey; a considerable attraction of the plumb-line to the south of the Dunnose station having been unequivocally determined, and which is supposed to depend on the intensity of the attraction of the hill. In alluding to this remarkable phenomenon, Sir Roderick Murchison (in his address at the meeting of the British Association of Science at Southampton, September, 1846) observed, "that it is a matter of surprise that this comparatively low chalk range in the Isle of Wight should attract, in one parallel at least, with more than half the intensity of the high and crystalline mountain of Schehallien in the Highlands of Scotland.[a] Can this be explained by the peculiar structure and distribution of the ridge of upheaved strata which runs as a back-bone from east to west through the

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[a] In the year 1774, from astronomical observations made on the mountain of Schehallien by Dr. Maskelyne, it was proved that a sensible disturbance was produced in the direction of the plumb-line by the attraction of the dense masses of granular quartz and limestone, and mica and hornblend slate, of which that mountain is composed.

siliceous nodules in these strata are always found entire; presenting in this respect a striking contrast to the shattered flints in the vertical strata that form the opposite range of Brading Down. (See Pl. VIII.)

COAST OF THE UNDERCLIFF.—The district of the Undercliff, from the western extremity of St. Catherine's Hill to Bonchurch, is about six miles; and the road from the west passes along an irregular terrace composed of fallen masses of chalk, marl, and firestone, which in the lapse of centuries have accumulated in a talus on the southern escarpment of the Downs. Although subsidences are occasionally taking place, and within the last hundred years from eighty to ninety acres of the upper cliff sank down at one time, the greater part of this singularly picturesque and lovely region has undergone no material change since the Conquest. This is evident from the ancient churches of St. Lawrence and St. Boniface, which are referred by antiquaries to the eleventh or twelfth century.* In travelling from Blackgang to Ventnor, the firestone cliffs are the most important geological feature. Here and there on the road-side are seen accumulations of debris, and projecting crags of chert and sandstone, which from their superior hardness have for years resisted the disintegrating effect of the elements. From the intermixture of calcareous and argillaceous earth resulting from the decomposition of the strata, a soil has been produced which supports a luxuriant vegetation. Even the refractory siliceous rocks are more or less clothed with foliage, for the ivy has insinuated itself into every cranny, and hangs in festoons of verdant tapestry over the cherty peaks.

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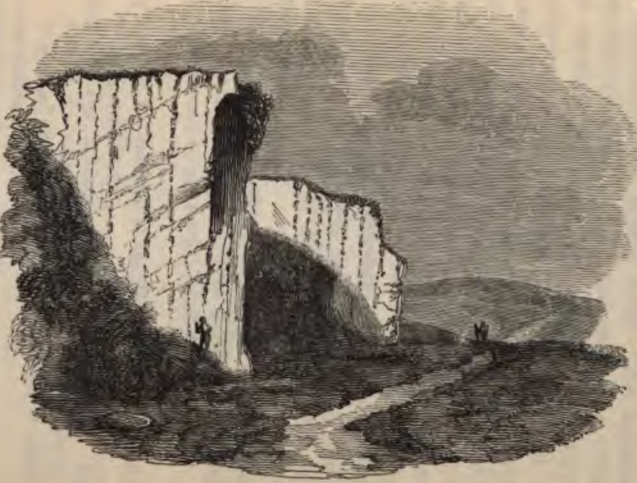
island? or is it to be referred to the effect of dense masses of plutonic rock ranging beneath the surface along the line of displacement of the deposits?"

* Sir Henry Englefield; "Isle of Wight."

Pl. XIII.



VERTICAL CHALK STRATA, WITH LAYERS OF SHATTERED FLINTS; IN A QUARRY ON BRADING DOWN.

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ASTOR, LENOX AND
TILDEN FOUNDATIONS

In many places the fallen blocks of sandstone are covered in relief with stems and bulbs of the *Siphonia Websteri* (*ante*, p. 177), and contain numerous shells. At Ventnor there are (or were) some bold vertical sections of the firestone; and an enormous mass of rock overhangs the road east of the Marine hotel. The calcareous sandstone here abounds in shells and molluskite. The terrace and sea-cliffs that form the southern boundary of this rapidly-increasing town are entirely composed of fallen masses of the upper groups of the cretaceous strata. In many instances huge fragments of white chalk appear imbedded in the greensand of the firestone; and I observed (in 1844) a series of chalk strata forty feet in thickness, surmounted by many feet of marl and firestone, forming a low headland on the sea-shore, the entire mass having been retroverted in its fall from the heights above. The diagram in lign. 20, p. 188, will serve to elucidate the above remarks.

The vicinity of Ventor is rich in the shells and zoophytes of the cretaceous system. The following localities have been pointed out to me by Mr. Saxby:—

The bank on the roadside at the Shute, above Ventnor, abounds in chalk-marl fossils.

Horse-shoe Bay, in black malm rock; many shells. Under the cliff to the east, called High-port, at low water, nodules of pyrites, generally having a terebratula or other shell as the nucleus.

East of Colin's Point and Mill Bay, the galt is visible and contains shells. In a highly-inclined fallen mass of sandstone, sharks' teeth, coprolites, molluskite, and many shells. Firestone with fossils occurs on the shore, eastward of the Parsonage.

In the gravel-pits on "Little-town Down," above Ventnor, the flints abound in sponges. They sometimes contain a sharp conical body fixed by its base, and projecting into an elongated fusiform cavity. This appearance has been produced by a *belemnite*, of which the large cavity is the impression,

gang; and beneath are the ferruginous sands and dark clays of the greensand. The layer of ironstone nodules full of casts of shells (see *ante*, p. 165) extends through the upper part of the cliff at Dunnose; but the *perna mulleti* bed has not been observed along this part of the coast.

Luccomb Chine, which lies between Chine Head and Dunnose Point, is an extensive gully like that of Blackgang, formed by springs derived from the high land on the north-west, and which, falling over a perpendicular cliff of sand and clay, have worn a deep ravine that is slowly receding from the shore. The celebrated chine of Shanklin is of the same character: the cliff here is 230 feet high, and the chasm extends 150 yards from the shore, being 300 feet wide at the top, and narrowing down to the bed of the torrent. The steep sides of the ravine are clothed with verdure and overshadowed by underwood, except where bare masses of rock protrude, and contribute to the picturesque effect of this romantic glen.

The character of the scenery around Shanklin so entirely depends on the geological structure of the country, that I am led to transcribe the following vivid description of this part of the Island by Sir H. Englefield:—"As we approach the village of Shanklin, its appearance is equally singular and interesting. It is seated in a small vale hanging towards the sea, at a great height above that level; the houses are detached from each other, and almost buried in groves of elms; and every cottager, however humble, being in the habit of letting lodgings in the summer season, surrounds his dwelling with a garden full of flowering shrubs. The whole spot has a most cheerful and uncommon character. The little church, which is of a pretty form, stands on a broken knoll open to a beautiful pasture, with groups of elms carelessly disposed about it; and it is backed by the high hill of Dunnose, whose lower part is covered with thickets and groves hanging down its steep sides.

From among these in one part a range of rocks starts out; the northern face of the same great stratum to which the Undercliff owes its existence and its beauty. The route from Shanklin church, by the road which winds through the open groves up the flank of Dunnose, is eminently beautiful, affording, as we ascend, the most lovely views. The village, with its groves, forms a charming first distance—the bay of Sandown with the Culver Cliffs present a noble winding shore; and beyond the low land of Sandown, in the direction of Brading Haven, a part of the anchorage of Portsmouth with its shipping is visible. From the top of the ascent the elevation of the ground is so much greater than the chalk hills of Yaverland, that the sea is visible over them; and the distant blue heights of Hampshire and Sussex form an uninterrupted line, till to the eastward they are blended with the horizon of the sea; emerging out of whose waters the white cliffs from Brighthelmston quite to Beachy Head are distinctly visible, though from forty to sixty miles distant."*

The western cliff of Shanklin Chine consists of an alternating series of clays and sands. The upper part is greenish-white sand, resting on a bed of dark-blue clay; beneath this is another stratum of sand, and a second bed of clay lying on a deposit of greenish-grey sand, with bands of sandstone. The lower part consists of ferruginous sands, with concretionary layers of greensand full of terebratulæ. The argillaceous partings have given rise to narrow ledges, which are verdant from a covering of rank grass; but slips are continually taking place from the wasting away of the sand, by the oozing of the water arrested in its descent from the porous strata above, by these beds of clay.

Along this shore numerous specimens of the gryphea sinuata are generally to be met with loose in the sea-sand, as at Atherfield; and ironstone concretions, full of shells that have fallen from the cliffs. In these nodules, leaflets of the Wealden fern (lign. 21) are sometimes found associated with trigoniæ, terebratulæ, &c.

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* Sir H. Englefield's "Isle of Wight," p. 70.

At the foot of the cliff near Shanklin Chine, the lower series of greensand strata emerge, and gradually rising to the surface, form the western coast of Sandown Bay. The view of the bay from Shanklin is extremely interesting, for the white chalk strata of Culver form the eastern promontory, and the galt, firestone, and greensands of Redcliff, succeeded by the low Wealden cliffs, may be distinctly traced.

Beyond the cliffs at Sandown is the vale of Newchurch, a low alluvial plain, protected from the inroads of the sea only by a thick bed of shingle; beneath which, at low water, the Wealden clay may be seen extending under the greensand strata on the east and west. The little inn on the shore and the fort now appear, and we reach the spot where our examination of the eastern side of Sandown Bay terminated.

Our excursions have now extended round the Island, and embraced the whole series of coast sections, with the exception of the Wealden cliffs that intervene between Compton Bay and Atherfield Point. A visit to Brook Bay will enable us to complete our survey, by an investigation of those highly interesting natural records of one of the most remarkable epochs in the physical history of our globe.

CHAPTER IX.

THE WEALDEN FORMATION—NATURE OF RIVER DEPOSITS—WEALDEN STRATA OF THE ISLE OF WIGHT—EXCURSION TO BROOK BAY—CLIFFS FROM COMPTON CHINE TO BROOK POINT—BROOK POINT—PETRIFIED TREES—STRUCTURE OF THE FOSSIL WOOD.

THE WEALDEN FORMATION.—The lacustrine and fluviatile origin of the strata spread over the northern part of the Island was clearly denoted by the prevalence of land and freshwater shells, and the remains of aquatic and terrestrial plants; and by the presence of bones of mammalia related to the tapir, peccari, &c., but referable to extinct species and genera; while the marine and estuary shells, and other exuviæ, in the deposits on which the freshwater beds were super-imposed, afforded conclusive evidence that these strata were formed in the basin of a comparatively shallow sea.

The cretaceous system, which so long engaged our attention, displayed, on the contrary, an assemblage of sedimentary deposits that had been accumulated in the profound depths of the ocean, in a period of unfathomable antiquity and of long duration. The innumerable relics of marine organisms showed that then, as now, the sea was teeming with life; while a few vestiges of terrestrial plants and animals attested the existence of dry land, inhabited by viviparous quadrupeds and clothed with vegetation, during the formation of this series of oceanic deposits.

The natural records of an antecedent epoch are now before us, and we proceed to examine an assemblage of strata, not of marine, but of freshwater origin, that was deposited ere the formation of the cretaceous rocks com- [illegible] these fluviatile sediments constituted the sea-bottom, over which was spread the first layer of the greensand (see p. 162). From the extension of these deposits over the Wealds of the south-east of England, and from their fluviatile characters having in the first instance been determined by observations on the strata and organic remains discovered in those districts, the formation has received the name of The Wealden.

Before entering upon the examination of the cliffs in Brook Bay, which will form the principal object of the present excursion, a few general observations on river deposits, and on the information to be derived from their investigation, as to the nature of the land, and its fauna and flora, may be necessary to enable the unscientific reader justly to appreciate the geological interest of the phenomena that will demand his notice—phenomena which, if rightly interpreted, will reveal a former condition of the earth's surface, more marvellous than any which even the wildest imagination has ventured to portray.

NATURE OF RIVER DEPOSITS.—The torrents that rush down the mountains' sides, and the streams and rivulets that meander through the plains, are more or less charged with earthy particles, worn from the rocks and strata over which the waters flow; and the united streams, in their progress towards the rivers, become more and more loaded with adventitious matter, and a great quantity of detritus is mechanically suspended in the water, and carried towards the sea. If the current is feeble, and the inclination of the ground but slight, a large proportion of the mud, pebbles, and gravel, subsides in the bed of the river; but the greater part is transported to the mouth of the stream, and accumulating in the bays and creeks, and around the embouchure of the river, gives rise to those deposits of alluvial debris termed deltas and estuaries. But the finest particles of the detritus are carried far out to sea, by the currents, and finally sink down, and form layers of mud

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the delta, and engulfed in the mud, silt, and sand; a
[illegible] kind are sometimes drifted out to sea, a
deposited in the bed of the ocean.

In the rivers of India and of America these operati
are in daily progress on an immense scale. In t
[illegible] formed of prostrate forests are transpor
to the delta of that mighty stream, and become buried
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[illegible] of the new world are engulfed.

[illegible] evident that should deposits of this nature becom
[illegible] the naturalist, by an examination of the imbedde
[illegible] remains, may with certainty determine the chara
[illegible] fauna and flora of the country whence the
[illegible] sediments were derived. Thus in the delta of th
[illegible] would find the bones and antlers of the dee
[illegible] and other domesticated animals, with the leave
[illegible] of the elm, oak, ash, and other trees and plant
[illegible], with human bones, fragments of pottery an
[illegible] works of art; while in that of the Ganges or th
[illegible] remains of the animals and plants of India or o
would be discovered.*

upon the consolidated mud and sand, and that the surface of the country is either covered with woods and forests, or under cultivation. If in natural or artificial sections of these deposits, the bones of men and animals, with works of art, and the remains of plants and river shells, should be found in the clays or sands, such appearances would excite in us no surprise, because we are acquainted with the processes by which the strata were accumulated; and should an inhabitant of the new country express his astonishment how fragile shells, and delicate leaves, and bones of animals became enclosed in the solid rock, and, refusing assent to our interpretation, attribute their presence to the effect of a deluge which softened the crust of the earth, and imbedded in the sediments of its waters the remains of animated nature,—our reply would be that such a catastrophe must inevitably have intermingled the relics of the animals and plants of the land, the rivers, and the ocean, and that the regular stratification of the materials, and the exclusively fluviatile and terrestrial character of the fossil remains, are fatal to such a hypothesis, and confirmatory of our explanation of the phenomena. It was by such a train of reasoning that the fluviatile origin of the Wealden deposits was established.

The strata composing the Wealden formation of the south-east of England admit of the subdivisions given in the tabular arrangement, p. 42. Alternating layers of clays, sands, and limestones almost wholly composed of freshwater univalves, and of small bivalves with minute crustaceans, form the upper series. Sand and sandstones, with bands of arenaceous limestones or calciferous grits, with shells and lignite, prevail in the middle group; while in the lowermost, sands, clays, and argillaceous shelly limestones again appear; and buried beneath the whole is a petrified forest of pine-trees with cycadeous plants, still erect in the soil in which they grew; and in all these [illegible] of colossal terrestrial reptiles are more or [illegible]. The upper clays and limestones occupy [illegible] of the Wealden districts that skirt the inner [illegible] of the chalk downs in Surrey, Kent, and [illegible] group of sands and sandstones con[illegible] of those counties; and the lower [illegible] the deep valleys in the east of Sussex, [illegible] Brightling, Burwash, and Ashburnham. [illegible] which are characterised by thick beds [illegible] principally formed of a small species of [illegible] coast of Dorsetshire, in the Island, [illegible] Peninsula, whence the name is [illegible] Wealden presents the most perfect example [illegible] hitherto discovered; in the numerous [illegible] in the systems of geology, there is [illegible] of so well-defined and extensive a group [illegible] deposits."

[illegible] years ago, though the Wealden districts [illegible] by hundreds of intelligent persons in their [illegible] London and Brighton, their freshwater [illegible] the whole group being considered by [illegible] with the sands, clays, &c., of the chalk [illegible] the shells forming the Sussex marble of [illegible] so long since as Woodward's time, [illegible] this point was controverted by some [illegible] if any other, organic remains had [illegible] the strata of the Weald. Having, for several [illegible] the fossils of the south-east of Sussex, [illegible] the specimens from different localities, I [illegible] want of accordance between the organic [illegible] and those which I had [illegible] and wells, opened or sunk in the [illegible] the freshwater character of the [illegible] Sussex, Kent, and Surrey became [illegible] echinites, terebratulæ, [illegible] fossils of the chalk, in [illegible] a circumstance that could not fail to [illegible] of the bones of large reptiles, The total thickness of the Wealden (inclusive of the Purbeck beds) is estimated at upwards of 1,500 feet, being equal to three times that of the delta of the Mississippi.[*]

Wealden Strata of the Isle of Wight.—In the Isle of Wight but a small portion of the upper series of clays, sands, and sandstones is exposed to view. These deposits constitute the line of coast already noticed, in Sandown Bay, and the range of cliffs from near Atherfield Point to Compton Bay. The section exposed in the cliffs on the south-western coast, is shown in lign. 16 (p. 157), from Dr. Fitton's Memoir; to which reference must be made for details, which, though of great value in a scientific point of view, possess but little interest for the general observer.[†] The Wealden strata forming this line of coast consist of laminated clays, shales, and loosely coherent sands, full of freshwater shells and crustaceans, with lignite, and in some strata abundance of pyrites; layers, a few inches in thickness, of tough bluish argillaceous shelly limestones, some being composed chiefly of bivalves, and

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with the leaves and stems of ferns, cycadeous plants, &c., in the strata of Tilgate Forest, of which there were not the slightest traces in the cretaceous deposits, corroborated the inferences suggested by my previous observations. In 1822 the Tilgate strata were first described, and their freshwater origin pointed out in "The Fossils of the South Downs." In June, 1822, I communicated to the Geological Society of London an account of the extension of these strata over Sussex, being the result of my own and Mr. Lyell's observations. In 1827, "The fossils of Tilgate Forest," containing nearly 200 figures of Wealden fossils, was published. See Dr. Fitton's charming little work—"A Geological Sketch of the Vicinity of Hastings." London, 1832. P. 13.

[*] The delta of the Mississippi is computed by Mr. Lyell to be 528 feet, or about the tenth of a mile in depth; the area it covers, 13,600 square statute miles; the solid matter annually added, 3 billions 700 millions cubic feet; and the period required for its formation, many thousand years.

[†] "Geol. Trans." vol. iv. second series, p. 197—220.

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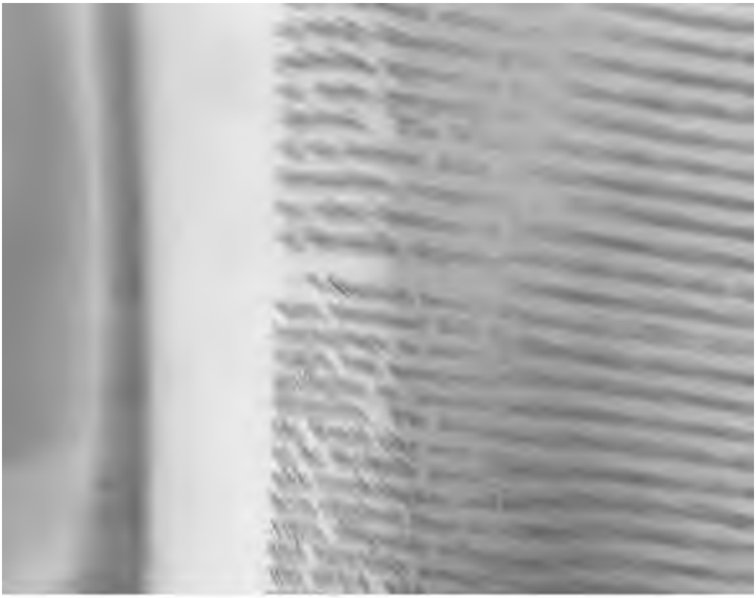

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height; and specimens of the shale, covered with cyprides and shells, may be obtained from the fallen masses on the shore.

The laminated clays and shales are succeeded, as we advance eastward by mottled plastic clays, containing bands of reddish and yellow sand, and hard-grit or sand-rock; and the strata gradually decline till we reach Brook Bay, where they are nearly horizontal.

From Bullface Ledge we perceive the low promontory of Brook Point that forms the eastern boundary of Compton Bay, and at its base a reef of rocks extending seaward to a considerable distance. If the tide is very low, a succession of ledges of this kind are visible along the shore, stretching out to the distance of half a mile or more from the land, and indicating the former extent of the southern coast of the Island, at a comparatively very modern period. These reefs and rocks consist of the harder masses of the Wealden sandstone, which have resisted the destructive effects of the waves, after the clays, sands, and softer materials have been swept away.

Brook Point.—As we approach Brook Point, the variegated sands and grit which lie beneath the clays become more developed; and large waterworn blocks of sandstone appear here and there on the shore. The ledge at the base of the cliff, which formed so prominent a feature of this part of the coast when seen from a distance, consists of indurated sandstone inclosing trunks and branches of large trees completely petrified, many of which are strewn along the strand, and half buried in the sand and shingle. The projecting masses at the foot of the cliff are the broken edges of the strata, and the trunks of fossil trees; the upper and less coherent deposits having been washed away.

The cliff is between thirty and forty feet high, and is capped by the bed of loam and gravel previously noticed at Compton Chine. Beneath this alluvial covering are laminated clays and shales, and sand and friable sandstone, occurri g in masses and layers of lignite; and minute ticles of the same substance are disseminated throughout the strata. Pyrites occurs abundantly in small nodules and spheroidal masses; and this mineral generally pervades the lignite and wood. Towards the base of the cliff are the beds of sand and sandstone, with hard concretionary grit, containing the fossil trees; and beneath these are seen at low water, compact variegated sands, which are the lowermost deposits in the Island. East of the Point is Brook Chine, a deep fissure or chasm that has been worn in the softer strata by the long continued erosion of a stream, which gushes out from beneath the sand beds inland, and flowing through the alluvial gravel to the top of the cliff, falls in a cascade to the sea-shore.

PETRIFIED TREES.—The prostrate fossil trees at Brook Point were first noticed by Mr. Webster thirty years ago.[*] After describing the clays and sandstones of the cliff, Mr. Webster states that he "observed many masses of a coaly blackness, bearing the exact form and resemblance of trunks of trees that had been charred, lying on the beach, and imbedded in the clay-cliffs, and also in the rock. In some parts the ligneous fibre was still evident; in others the wood had been converted into a substance much resembling jet, its blackness being intense, its cross fracture conchoidal, and its lustre very great. Other parts of the trees were entirely penetrated by pyrites, and groups of crystals of this substance were frequently attached to the outside. On lifting up some of the sea-weed that grew upon the shore between high and low water-mark, I was astonished to find almost all the rocks below them composed of petrified trees which still retained their original forms. The knotty bark and ligneous fibre were very distinct; and trunks and branches were frequently imbedded in masses of clay now indurated and in the state of argillaceous rock."

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[*] Englefield's "Isle of Wight," p. 153.

Upon first reading the above description, my curiosity was strongly excited, and when in the course of my researches in the strata of the Wealds of Sussex, the fluviatile origin of those deposits became evident, I felt an irresistible desire to visit Brook Point, in the expectation of beholding a petrified forest of the country that had been inhabited by the colossal reptiles, of which so many remains had been discovered in Tilgate Forest. Nor was my expectation disappointed; I have visited this coast many times, and always with increased interest—an interest which I hope to excite in some of my intelligent readers, and induce them to repair to the spot, and investigate the phenomena, of which these pages can present but a feeble outline.* The trees are all lying prostrate and confusedly intermingled. There are no erect trunks, nor any other indications that the forest was submerged with its native soil, like that of the Isle of Portland.† On the contrary,

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* In June 1823, my friend, Mr. Lyell, visited Compton Bay for the purpose of ascertaining more clearly the relations between the ironsand of Mr. Webster and the strata of Tilgate Forest, of which an account had appeared in my "Fossils of the South Downs." In a letter detailing the result of his investigation, Mr. Lyell remarks:—"At Compton Chine, I found in Webster's blue marl several small Inocerami (*I. sulcatus*), and some other characteristic shells, so that I believe the identity of this bed with the Folkestone galt might be made out by further research. The section from Compton Chine to Brook is superb. We see there at one view the whole geology of your district, from the chalk with flints down to the battel beds, and all within an hour's walk.—This is so beautiful a key, that I am at a loss to conceive how so much confusion has arisen.—The softness of the Weald clay has caused a ruinous state of the cliff just where the Sussex marble ought to be. Soon after this, layers of limestone with bivalves appear; then some mottled beds; then pyritous coal (lignite) like that at Bexhill, I presume.—In Sandown Bay I picked up a block of Petworth marble two feet in diameter, of which, and the other rocks, I will send you specimens."

† "Wonders of Geology," vol. i. p. 362.

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are calcareous, not siliceous like those of Portland. The wood is more or less traversed by veins and filaments of pyrites, which impart a beautiful appearance to polished specimens of the stems. Slices rendered transparent by Canada balsam, exhibit under the microscope, in the transverse sections, the cellular tissue as a reticulation of polygonal meshes; and in the radial, the ducts or glands characteristic of the coniferæ, and arranged in alternate rows as in the araucaria or Norfolk Island Pine.* The annular lines of growth are often very distinct; I have traced from thirty to forty on some of the stems. These circles are of unequal thickness, and therefore indicate a variation from year to year in the climate of the country in which they grew. They are, too, as small as in the slow growing pines and firs of England. Many of the stems exhibit an obliquity in the annular lines, proving that they grew in situations which exposed the trees to prevailing currents of wind from a particular quarter, and caused them to incline in the opposite direction. I have discovered no vestiges either of the foliage or fruit. It is remarkable that coniferous wood occurs but sparingly, if at all, in the Wealden deposits of the south-east of England; but drifted stems and branches of pines of the araucarian type, are common in some of the upper beds of the greensand, and are occasionally met with in chalk flints.†

Such is a brief description of the accumulation of fossil trees at Brook Point, which evidently originated in a raft composed of a prostrate pine-forest, transported from a distance by the river which flowed through the country whence the Wealden deposits were derived, and became submerged in the sand and mud of the delta, burying with it the bones of reptiles, mussel-shells, and other extraneous bodies it had gathered in its course.

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* See "Medals of Creation," vol. i. p. 71.

† "Medals," vol. i. p. 168.

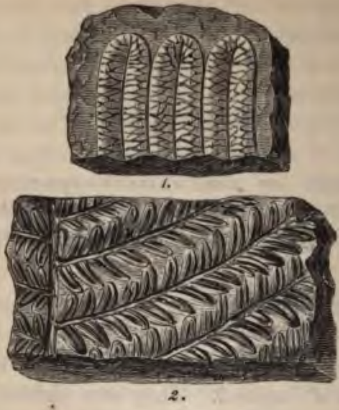
CHAPTER X.

ORGANIC REMAINS OF THE WEALDEN—FOSSIL VEGETABLES—ENDOGENITES EROSA—CYCADEOUS PLANTS—CLATHRARIA LYELLII—FOSSIL SHELLS—UNIO VALDENSIS—FOSSIL CYPRIDES—FOSSIL FISHES.

FOSSILS OF THE WEALDEN.—The Wealden strata of the Isle of Wight have afforded examples of the most characteristic organic remains that have been discovered in this formation in other parts of England. They have yielded five or more genera of terrestrial plants; of which one belongs to the Pines, several to the Cycadeæ, and two or three to the Ferns: several species of river-shells, of the genera Unio, Paludina, Potamides, Cyclas, &c.; and of the small crustaceans, the Cyprides. Fishes allied to the Bony-pike and the Sharks occur, and bones of seven or eight species of terrestrial saurian reptiles, and of two or three genera of Chelonians.

FOSSIL VEGETABLES.—Our description of the fossil forest of Brook Point entered so fully into the character of the coniferous trees of the Wealden, that it is unnecessary to enlarge upon that subject. A great proportion of the lignite in the laminated sands and clays forming those cliffs, is undoubtedly the bark of the mature trees, and the wood of the young plants, in a carbonized state.

But the coaly particles disseminated through the strata have probably, in a great measure, originated from the foliage of two elegant extinct species of ferns, that abound in some parts of the Wealden of Sussex, and of which a few recognisable specimens have been discovered in the Isle of Wight.



LIGN. 21.—A FOSSIL FERN (*Lonchopteris Mantelli*) FROM THE WEALD CLAY; BROOK POINT.

Fig. 1.—Portion of three leaflets, magnified, to show the reticulations of the veins.
2.—Part of a stem, with leaves.

FOSSIL FERNS.—Entire layers of the sandstone, grit, and shale, in Tilgate Forest, are so full of carbonaceous matter as to acquire a dark mottled colour, and this detritus is composed of minute particles of the leaves and stems of ferns, that have been ground to pieces by agitation in water loaded with sand and mud. One of these plants (*Sphenopteris Mantelli*, "Wonders of Geology," p. 370) is characterised by its slender wedge-shaped leaflets. The other fern (*Lonchopteris Mantelli*, lign. 21) is the species already mentioned as occurring in the greensand of Atherfield and Shanklin. It is distinguished by its long and many-times pinnated leaves, and the reticulated disposition of the secondary veins that spring from the mid-rib of the leaflets.

ENDOGENITES EROSA.—In the strata of Tilgate Forest, and in the sands at Hastings, numerous fragments of the stems of a remarkable monocotyledonous (?) plant occur, and are mentioned in my Fossils of the South Downs, and figured in the Fossils of Tilgate Forest, &c. These stems are of various forms; some are cylindrical, and tapering at both ends; and others are flattened, and of a clavated shape, like some of the *Cacti* and *Euphorbia;* the specimens are from a few inches to seven or eight feet long, and the largest from twenty to thirty inches in circumference. When imbedded in the strata, a thick coat of lignite surrounds the stem; but this soon becomes friable, and falls off after exposure to the air. The constituent substance of the stems is a grey, compact, subcrystalline sandstone, and the external surface is traversed by fine semicircular grooves and deep tubular furrows, lined with minute quartz crystals; a transverse section exhibits the surface covered by small pores, and a few large openings, the sections of the tubes. From the eroded appearance of the surface of the specimens, when deprived of their carbonaceous investment, the name *Endogenites erosa*, was given to this fossil plant by Messrs. Stokes and Webb, who described it from my specimens, in the "Geological Transactions," vol. i., second series. Dr. Fitton* subsequently described and figured a series of interesting specimens observed by him in the strata at Hastings. In transverse slices of these fossils, obscure indications of circular bundles of vascular tissue were detected, but (as in all my specimens from Tilgate Forest) very few vestiges of organic structure were apparent; the cavities exposed in the sections being not the vessels themselves, but the hollows left by their decay.† The occurrence of this fossil plant in the Wealden of the Isle of Wight has only recently been discovered. Among the waterworn fossils which I collected from the shingle, on my last visit to Brook Point, was a rounded, wide, rounded above, and contracted below, as shown in the detached petiole figured in lign. 24; they are traversed by fine and nearly parallel longitudinal veins. The summits of those petioles from which the leaves appear to have been shed, not broken off, are marked by vascular pits disposed with great regularity, as shown at *c*, lign. 24; a structure which M. Adolphe Brongniart informs me partakes more of the character of the Ferns, than of the cycadeæ. The substance of this fossil is a sandy marl, and probably does not retain any traces of the internal structure of the original; still it is desirable that sections of the petioles and of the stem should be microscopically examined. M. Adolphe Brongniart, to whom I transmitted a sketch of this specimen of the natural size, immediately favoured me with his remarks on this interesting fossil. He considers the specimen to be the upper termination of a stem of the clathraria, garnished with persistent leaf-stalks; and that some of the uppermost petioles were broken off accidentally while the leaves were alive; but that in the lower ones, which possess vascular markings on their summits, the leaves were detached naturally, and these petioles remained, probably for some years, as is the case in the existing cycadeæ. The petioles having fallen from the exposed part of the stem, the surface is left bare, and is

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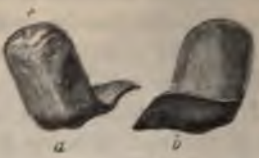
* "Geol. Trans." vol. iv. p. 172.

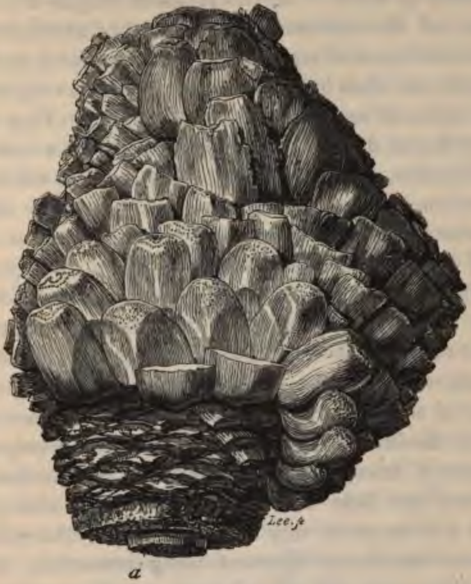
† Dr. Fitton has given magnified figures of the sections in his pl. xx.



LIGN. 24.—A PETIOLE OF CLATHRARIA LYELLII, SEPARATED FROM THE STEM.

a, the external aspect;
b, the internal surface;
c, the vascular markings left on the summit of the petiole by the separation of the leaf.

marked by lozenge-shaped cicatrices or scars, which are the points of attachment of the bases of the leaf-stalks.



LIGN. 23.—CLATHRARIA LYELLII.

From the chalk-marl at Bonchurch, Isle of Wight; discovered by CAPTAIN IBBETSON.

This fossil is the summit of a stem garnished with petioles or leaf-stalks on the upper part: from the lower portion the petioles have been removed. The internal axis is seen at *a*. The original is fifteen inches in length, and eleven and a half in the widest transverse diameter.

On the other side of the specimen there appeared to me indications of the foliage, but M. Brongniart suggests it as more probable that they are only elongated and flattened petioles.

The occurrence of this [illegible] [illegible] Wealden [illegible] upon the chalk [illegible] with the discovery of the bones of the [illegible] [illegible] of Kent.* In the strata of Tilgate Forest [illegible] remains of the [illegible] are [illegible] associated with [illegible] bones of reptiles, and [illegible] drift, and are often imbedded [illegible] conglomerate which occurs in some parts of the Wealden.† They appear to have floated down the river with the [illegible] and [illegible] of the reptiles, and at length to have sunk to the bottom, and become imbedded in the mud and sand of the delta.

Fossil Shells.—The shells of the Wealden of the Isle of Wight belong to the same genera and species of fluviatile mollusks as those in the contemporaneous deposits of the south-east of England; and though spread over areas of considerable extent, and through deposits of great thickness, they comprise but a few species—a characteristic feature of the fauna of all rivers. The substance of the shells in the limestones is, for the most part, changed into carbonate of lime; but the shells in the argillaceous strata are often but little altered, and sometimes occur in as perfect a state as in very recent deposits; the epidermis and even the horny ligament being preserved. In the coarse limestones the shells have generally perished, and casts only remain.

Sussex and Petworth Marble.—The most abundant univalve shells are four or five kinds of *Paludina*; a common river snail, of which there are species in the tertiary freshwater strata of Headon Hill and Calbourne. (See Pl. I. fig. 6.) Numerous beds of marble, coarse limestone, clays, and shales, abound in or are wholly made up of paludinæ and minute crustaceans. The compact Sussex limestone, which, from its taking a good polish, is called marble, principally consists of the shells of one large species, the *Paludina fluviorum* (Pl. VI. fig. 3), held together by an infiltration of crystallised carbonate of lime ; the cavities of the shells, and the interstices between them, being often filled with white calc-spar. Upon examining thin slices of this marble under the microscope, the shells are found to contain myriads of the cases of *Cyprides* (lign. 25). The Purbeck marble differs from the above in being composed of a much smaller species—the *Paludina elongata*. (Pl. VI. fig. 2.)

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* "Wonders of Geology," vol. i. p. 304.

† See remarks on the "Discovery of the Hylæosaurus," in "Wonders of Geology," vol. i. p. 401.

These marbles were in great repute with the architects of the middle ages, and there are but few of our cathedrals and ancient churches which do not still contain examples of both varieties, either in their columns, sepulchral monuments, or pavements. The polished cluster-columns of the Temple Church in London, and many of the monuments in Westminster Abbey, are of Purbeck marble; in other words, they are composed of the petrified shells of snails, that lived and died in the rivers which flowed through the country inhabited by the extinct colossal reptiles. The dark masses and veins so common in these marbles, are the remains of the bodies of the mollusca, changed into the carbonaceous substance termed *molluskite*. (See *ante*, p. 181.) The shells which were empty at the period of their becoming imbedded, had their cavities filled with the mud, silt, &c., which are now clay, marl, and limestone; but in the shells containing the animals, the gelatinous parts were converted into molluskite. In polished sections of the marbles this substance appears either within the shells, or in black or dark brown masses and veins. The most beautiful slabs of Sussex marble owe their variegated markings to the contrast produced by the black molluskite with the white calcareous spar.

POTAMIDES.—Some species of the elongated, spiral, [illegible] few [illegible]

[illegible] with

[illegible] by

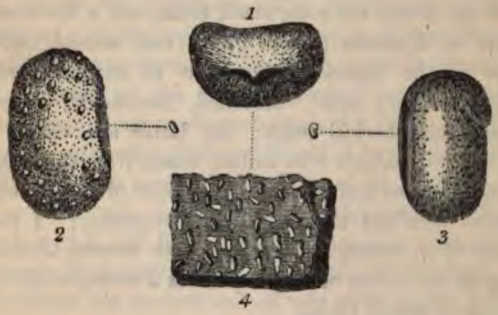
[illegible] in our

[illegible] p. [illegible]

Many of the slabs of limestone procured from Sandown y, and used in the pavements at Brading, Ryde, &c., splay sections of a species of unio, which is common in me of the Petworth and Purbeck beds. On a visit to rook Point in 1843, I discovered a remarkably fine and rge species of unio in the cliff above the petrified trees, nd have since collected many specimens of this interesting ossil, which I have proposed to distinguish by the name of *Unio Valdensis*, or Wealden river-mussel. A small and young example is figured in Pl. VI. fig. 1; the hinge and the anterior muscular imprints are shown in the upper figure. The specimens obtained from the cliffs are in an excellent state of preservation; the surface of the shell, which is but little worn, is of a tawny-red colour, like some of the recent Ohio species. Even the horny ligament with its transverse rugæ remains; and in some instances the shell is occupied by the body of the animal in the state of molluskite. The constituent substance of the shell is occasionally changed into calcareous spar, and admits of a fine polish. Nodules of crystallised sulphate of barytes of a pink colour, are not uncommon within the shells. Some examples which I extracted from the bed containing the fossil trees, are partially invested with lignite. One pair of valves has been separated, and the hard grit with which they were filled cleared away, so as to develop the characters of the hinge, &c.

The shell is of an ovate form, from four to six inches long, three inches in altitude, and two inches in thickness or diameter; the weight of a pair of valves cleared from extraneous matter is eleven ounces. The shell is equivalved, sub-equilateral, the posterior half one-fifth longer than the anterior, and compressed along the margin of the anterior slope. It is very thick and strong, and marked externally with longitudinal striæ. The summit is rounded, antero-dorsal, and slightly inclined forward; the umbones are decorticated, as in most of the shells of the Unionidæ. The ligament is external, post-apicial, and marked with transverse rugæ.

with their exuviæ. The largest living cypris does not exceed one-sixth of an inch in length. In a fossil state these cases appear like minute, white, elliptical, or reniform scales, on the surfaces of the recently separated laminæ of clay, shale, and limestone. After exposure to the weather the cases decompose, and leave the surface of the stone covered with their casts, which appear as minute polished tubercles; some layers of the compact ironstone have a granulated appearance from the abundance of these remains. Three species of the Wealden cyprides are represented in lign. 25.



LIGN. 25.—FOSSIL CYPRIDES; FROM BROOK BAY.

Fig. 1. *Cypris spinigera;* the small figure shows the natural size.
2. *Cypris granulosa.*
3. *Cypris Valdensis.*
4. Clay, with numerous cases of the species represented fig. 1, of the natural size.

The immense accumulation of the remains of these crustaceans in the Sussex marble is quite surprising; some slabs which I have examined under the microscope, have the shells and their interstices literally crammed with whole and broken cases. As the recent species inhabit either still lakes or gently flowing streams, and not the turbulent waters of estuaries, it follows that sediments largely charged with the exuviæ of cyprides must have been deposited in lakes, or bays, or in tranquil streams, communicating with the flood of waters which transported to their present situation the bones of terrestrial animals and plants. These beds of fluviatile shells and cyprides, with scarcely any intermixture of other organic remains, which are spread over such wide areas of the Wealden formation, afford, therefore, decisive proofs of tranquil subsidence in freshwater.

FOSSIL FISHES.—But few remains of fishes have been found in the Wealden of the Island; those which have come under my notice are some small teeth, and a fin-bone, of a species of *Hybodus* (see p. 170); and several teeth and scales of the *Lepidotus*, a genus of extinct freshwater fishes, with very thick, enamelled, rhomboidal scales, and obtuse hemispherical teeth; the latter are called fishes' eyes by the peasants who collect fossils from these shores.* Detached scales and teeth of two species of Lepidotus occur in most localities of the Wealden deposits.† I found a portion of an intermaxillary bone with several teeth, and a group of ten scales of the *Lepidotus Fittoni*, in the cliff to the east of Brook Chine.

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* Figures of the scales and teeth of one species of Lepidotus of the Wealden are given in "Medals of Creation," p. 438, Pl. VI., fig. 10.

† It is rare to meet with any considerable number of scales in contact; but a few specimens were discovered in Tilgate Forest, exhibiting part of the cranium, the opercula of the gills, the pectoral and dorsal fins, and large masses of scales. These are now in the British Museum, in the room appropriated to fossil fishes.

CHAPTER XI.

FOSSIL BONES OF REPTILES—THE IGUANODON—HYLÆOSAURUS—MEGALOSAURUS—CETIOSAURUS—STREPTOSPONDYLUS—PLESIOSAURUS—TURTLES—IMPRINTS ON SANDSTONE—RIPPLE-MARKS—SUMMARY—THE COUNTRY OF THE IGUANODON—VOYAGE ROUND THE ISLE OF WIGHT.

Fossil Bones of Reptiles.—The occurrence of bones and teeth of gigantic terrestrial reptiles in the beds beneath the chalk of the south-east of England, was first announced in the "Fossils of the South Downs," in which many remains of oviparous quadrupeds from the strata of Tilgate Forest are described. Relics of this kind have subsequently been discovered in numerous localities of the Wealden, and nowhere more abundantly than in the Isle of Wight; although search for these highly interesting remains has not hitherto been very actively or judiciously pursued.

The bones are washed out of the cliffs by the inroads of the sea, and strewn on the shore, where they become exposed to the action of the waves, and are soon abraded and deprived of any processes, or other anatomical characters, they may have retained after their original exposure to attrition in the river by which they were transported and imbedded in the strata. Thus those parts which would afford the most valuable information to the anatomist become entirely defaced, and the specimens are for the most part waterworn masses of bone, indicating only the enormous magnitude of the animals to which they belonged. The bones, even when imbedded in the sandstone and sand, are in general abraded, from having been transported by water from a considerable distance; those in the clays are [illegible] must have [illegible]

[illegible] some of the [illegible]

[illegible] than even the la

[illegible] British Museum.

[illegible] obtained sev

[illegible] Sandown Bay, an

[illegible] Mr. James V

[illegible] are now in the collect

[illegible] In [illegible] Mr. Joh

[illegible] collected several large vertebr

[illegible] two thigh bones, and ma

It must be borne in mind that these fossils have, for the most part, been picked up by persons wholly uninstructed as to the characters which alone render such specimens interesting. What the waves cast up on the strand, the fishermen gather together, the casual visitor selects such as please his fancy, and the remainder are thrown away, or employed to pave the footpath, or surround the flower-border of the cottager's dwelling.*

The remains hitherto found, are separate bones belonging to the well-known Wealden reptiles, viz. the *Iguanodon, Hylæosaurus, Megalosaurus*, and *Streptospondylus*; and the *Cetiosaurus, Plesiosaurus*,† and two or more kinds of turtles. I have seen but two teeth; a fragment of one belonging to the megalosaurus, and the specimen figured in lign. 27.

THE IGUANODON.—Of this most gigantic of terrestrial reptiles, which, when living, must have more nearly resembled in its magnitude and huge proportions, the largest of our living pachydermata, than any of the saurian order to which it belongs, many vertebræ, portions of ribs, and bones of the extremities, have been discovered in the Wealden at Sandown Bay, and at Brook and Brixton. The vertebræ are invariably deprived of their processes; even the neural arch is in general destroyed, and the

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Iguanodon from the Isle of Wight," "Geological Transactions," vol. iii. new series.

* The largest toe-bone of the iguanodon now in my possession was obtained from a row of stones placed round the flower plot of a cottage near Brixton. I much regret that my professional engagements have rendered it impossible for me to attempt to remedy the evil mentioned in the text.

† Having given a concise exposition of the osteological characters of these extraordinary beings in the "Medals of Creation," (vol. ii. p. 684, ch. xvii. and xviii.) with full instructions for the collection of their remains, to that work I beg to refer the reader desirous of pursuing these inquiries.

waterworn body, or centrum of the bone, alone remains.* The specimens are commonly permeated with pyrites, and in consequence, are of great weight. The long bones of the limbs are for the most part mutilated, and but seldom have an articulating extremity so perfect as to indicate the individual bone. Some of the fragments, however, retain characters sufficiently recognisable, and have unquestionably belonged to reptiles of enormous size. I obtained from Sandown Bay the lower half of a tibia (large bone of the leg), having the extremity that articulates with the foot perfect; the circumference of this bone is four times that of a perfect tibia of a young iguanodon, which is one foot long: when entire, its length must therefore have been nearly four feet. The corresponding thigh-bone, estimated from the relative proportions of a femur and tibia in juxtaposition, would be a foot longer: the entire length of the leg and thigh to which the Sandown fossil belonged, must consequently have been upwards of nine feet.

The most perfect femur, or thigh-bone, collected in the Isle of Wight, was dug out piecemeal from a fallen mass of the cliff in Brook Bay: it evidently belonged to an aged individual, and though squeezed and somewhat distorted by pressure while softened by long immersion in the clay in which it was imbedded, well displays the peculiar characters of this part of the skeleton of the iguanodon. It is 3 feet 4 inches in length. The figure in lign. 26 is a representation of this specimen, as it would appear if uncompressed. The femur of the Iguanodon is so remarkable, that even fragments may readily be distinguished; and as portions of this bone are not unfrequently to be met with in the clay cliffs or on the shore, I subjoin the following description.

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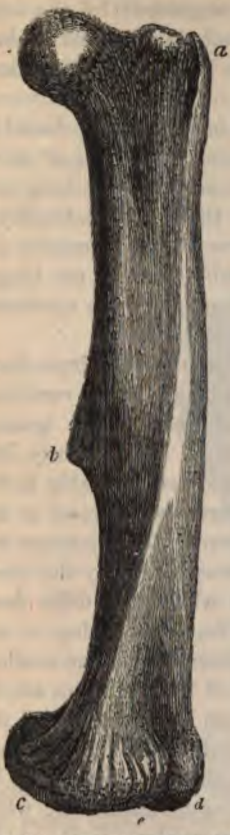
* As shown in lign. 138, fig. 8, p. 697, "Medals of Creation," vol. ii. The perfect form of a caudal vertebra of the Iguanodon is represented [illegible] the same lignograph.



LIGN. 26.—LEFT FEMUR OF AN IGUANODON. From Brook Bay.
(*The original, 40 inches in length.*)
a, Upper trochanter.
b, Middle trochanter.
c, Inner, *d*, outer condyle.
e, Groove between the condyles.

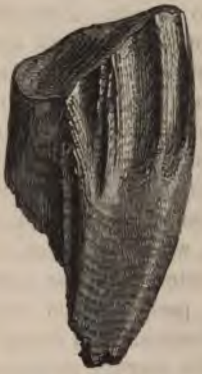
The head is hemispherical, and projects inwards; a laterally flattened process, or trochanter (lign. 26, *a*), forms the external boundary of the neck of the bone, from which it is separated by a deep and very narrow vertical fissure. The shaft is sub-quadrangular; a slightly elevated ridge, produced by the union of two broad, flat, longitudinal surfaces, extends down the middle of the anterior face, and diverging towards the inner condyle, gradually disappears. The shaft terminates below in two large rounded, and laterally compressed condyles (*c*, *d*), which are separated in front and behind by a deep groove (*e*). Near the middle of the shaft, the mesial, or inner edge, forms a compressed ridge, which extends into an angular projection, or inner trochanter (*b*). Thus the upper part of the femur may be known by the presence of the upper trochanter (*a*); and if that process is broken away, the fractured surface indicating its position will be detected. If a fragment of the middle part of the shaft only is found, the flattened angular spaces, and the submedian trochanter (*b*), or the [illegible] of the [illegible]

[illegible]

[illegible]

[illegible] Wonders

by its pressure, occasioned the absorption of the fang of the old one. In the perfect tooth, the crown is of a prismatic form, with three or four longitudinal ridges down the front, and a broad denticulated margin on each side.* The resemblance between the unworn teeth of the iguanodon and those of the iguana, a herbivorous lizard of the West Indies, suggested the name of this colossal extinct reptile; but the teeth of the iguana are very small, not exceeding in size those of the mouse.



LIGN. 27.—TOOTH OF AN IGUANODON.
From the Wealden, Brook Bay.

Sections of the teeth are beautiful objects under the microscope, and show that the structure of the dentine, or tooth-ivory, is coarser than in other reptiles, and resembles that which characterises the teeth of the Sloth tribe. The crown of the tooth is incrusted with an external coating of enamel, which is thick in front, and thin on the inner surface. In consequence of this disposition, and of the dentine being hardest in the anterior part, the grinding surface of

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* "Medals of Creation," p. 741.

[illegible]

[illegible] from various localities of the [illegible] the aid of the few specimens in which [illegible] in the same block of stone, the size

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[illegible] vol. i. p. 390.

[illegible] in the interesting museum of W. D. Saull, Esq., [illegible] Street, City, to which visitors are, with great [illegible] every Thursday at twelve. Mr Saull's collec[illegible] contains many specimens from the Isle of [illegible] and proportions of the body and limbs of the iguanodon may be determined; yet but a vague idea of the form and appearance of the original animal can be derived from the relics hitherto discovered. For the great discrepancy between the known parts of the skeleton, and the corresponding bones in the largest existing saurians, renders it vain to attempt the restoration of the form of this colossal reptile, till the skull, jaws, &c. are known. In all probability the entire or a considerable portion of the skeleton of a young iguanodon, will sooner or later be brought to light, and yield the information necessary to enable the palæontologist to reconstruct the skeleton, and delineate the form of the living original.

In the present state of our knowledge we may, however, safely conclude, that the body of the iguanodon was equal in magnitude to that of the elephant, and as massive in its proportions; for being a vegetable feeder, a large development of the abdominal region may be inferred. Its limbs must have been of a proportionate size to sustain so enormous a bulk; one of the thigh-bones (in the British Museum) if covered with muscles and integuments of suitable proportions, would form a limb seven feet in circumference. The hinder extremities, in all probability, presented the unwieldy contour of those of the hippopotamus or rhinoceros, and were supported by a very strong short foot, the toes of which were armed with claws like those of certain turtles.* The forelegs appear to have been less bulky, and furnished with hooked claws resembling the ungueal phalanges of the iguana. The teeth demonstrate the nature of the food required for the support of this herbivorous reptile, and the power of mastication it enjoyed. The palms, ferns, cycadeous plants, and coniferous trees, with which its remains are associated, indicate the flora adapted for its sustenance. But the physiognomy of this possessed a very formidable dermal covering: it had rows of elliptical and circular dermal bones along each side of the vertebral column, and appears to have been armed with a series of angular spines of great size, arranged along the middle of the back; in the same manner as the dorsal fringe of the iguana. The structure of the bone composing these dermal processes closely resembles that of the ligamentous fibres of the *corium*, or skin, and seems to have resulted from an ossified condition of the dermal integument. A few detached vertebræ of the hylæosaurus, recognisable by their perfectly circular and nearly flat extremities, have been found in the Weald clay at Brixton.*

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* "Wonders of Geology," pl. III.

MEGALOSAURUS.†—This name was given by Dr. Buckland to an enormous reptile, of which teeth and bones were first observed in the oolitic limestone of Stonesfield, near Oxford, and afterwards in the Wealden strata. The teeth present a striking contrast to those of the iguanodon; they are sabre-shaped, with trenchant serrated edges. The original was probably carnivorous, and nearly thirty feet in length. As it was contemporary with the iguanodon and several other large saurians, it may have preyed on their young and on the lesser reptiles. Many teeth, vertebræ, and portions of the femur of this animal, have been found in the island. The vertebræ are not subquadrangular like those of the iguanodon, but are cylindrical at the ends and contracted in the middle, and have a very smooth surface. The femur is nearly cylindrical and slightly bowed; it has two large rounded prominences, or trochanters of nearly equal size, below the head of the bone; it may therefore easily be distinguished from the thigh-bone of the iguanodon.

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* See "Medals of Creation," p. 734, and "Memoirs on the Fossil Reptiles discovered in Tilgate Forest." "Philos. Trans." part II. for the year 1841.

† See Dr. Buckland's "Bridgewater Essay."

USAURUS.—This extinct reptile, as its name im-
ts. bore some resemblance to the cetaceans. The
ræ are almost circular at the ends, and have a very
body; the front articulating surface is nearly flat,
other concave, in the dorsal vertebræ, but in the
both ends are deeply hollowed; they are very large,
eight inches in diameter. By these characters the
tebræ of the cetiosaurus may easily be recognised. I
ve obtained several from the Weald clay at Sandown and
ook. The original animals are supposed to have been
aquatic, and probably of marine, habits, on the evidence
he sub-biconcave structure of the vertebræ, and of the
cancellous tissue of the long bones, which are desti-
f a medullary cavity. They must have rivalled the
les in bulk, for some remains indicate a length of forty
ifty feet.[*]

STREPTOSPONDYLUS.—Among the large vertebræ washed up on the shore in Brixton Bay, I found several with one end convex and the other concave; these belong to the extinct crocodilian reptile called *Streptospondylus* (meaning *reversed-spine*), because these vertebræ are arranged in the spinal column in a position the reverse of that which obtains in all other reptiles of the same osteological type; for the convexity or ball of the vertebræ is placed anteriorly, whereas in the crocodile, &c. it is in the opposite direction.[†] The original, in its form and habits, probably bore a general relation to the crocodiles.

PLESIOSAURUS.—The splendid collection in the British Museum, which contains several perfect skeletons of different species of this genus of extinct marine reptiles, must be too well known to render any description necessary of the osteological characters of the plesiosauri and ichthyosauri. A few vertebræ of plesiosauri are the only remains of these animals I have obtained from the Island.

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[*] "Medals of Creation," vol. ii. p. 726.

[†] "Cuvier's Recherches sur les Ossemens Fossiles," tom. V. pl. 6.

FOSSIL TURTLES.—Of chelonian reptiles, waterworn fragments of bones are the only vestiges that have come under my notice. Some of these fragments in all probability belong to the *Trionyx Bakewelli*, a species which occurs in the Wealden strata of Tilgate Forest,* and is characterised by the granulated surface of the costal plates, and a dermal covering of tortoise-shell, as is shown by the imprints of the scales left on the bones. Except in possessing a defensive integument of this kind, this extinct chelonian must have resembled the existing predaceous soft turtles; and doubtless like them inhabited the mud-banks of rivers, and preyed upon the eggs and young of the larger reptiles, and on the uniones and other mollusca, the shells of which are often found associated with its remains.

IMPRINTS ON SANDSTONE.—We must here conclude our description of the fossils that have been discovered in the Wealden strata of the Isle of Wight; to attempt a full exposition of the characters and relations of these organic remains, would require a volume expressly devoted to the subject. A few additional remarks are, however, necessary on some anomalous appearances in the sandstone of Brixton Bay, that have recently come under my notice. The occurrence of imprints resembling the foot-tracks of birds and reptiles, on the surface of slabs of sandstone of very ancient formations, must be known to the well-informed reader, from the lucid illustration of the subject in Dr. Buckland's "Bridgewater Essay." Among those supposed foot-prints are several of large dimensions, described under the name of *Chirotherium*, which are conjectured to have been made by some enormous three-toed reptile, passing over the stone when it was in a soft state. Others equally colossal, from

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* "Geology of the S.E. of England," p. 255. "Medals of Creation," p. 778.

gement of the markings on the slabs indicating
gressive footsteps of bipeds, have been ascribed to
c extinct birds.[*] The layer of clay, or sandstone,
ng these imprints, generally retains casts of them,
appear in relief on the surface of the slabs when
l; in other instances the cast of a single mould alone
and being more consolidated than the matrix, is
tracted whole. Several large sandstone casts of
were discovered last year in the Wealden sands
gs, and sent up to the Geological Society. A
ast has been obtained from the Wealden sand in
in Brixton Bay, and is in my possession. This
is a solid tripartite mass of fawn-coloured sand-
he middle process is fifteen inches, and the two
rojections are twelve inches in length ; the greatest
s is six inches ; the processes are laterally com-
and rounded at the extremities, and united to one
base. As the origin of these singular concretions
is very problematical, every specimen should be preserved ; and if several occur on the same bed of sand, their relative position should be carefully ascertained.[†]

Ancient Ripple-marks.—Connected with this subject are the ripple-marks so often pervading extensive surfaces of sands, sandstones, and clays, in sedimentary deposits that have been formed on sea-shores, or along the banks of rivers, or in bays, deltas, lakes, and estuaries, in comparatively shallow water. In many parts of the Wealden formation these appearances are very striking; especially in the vicinity of Horsham,* and in the quarries in Tilgate Forest in Sussex.† The slabs of limestone, clay, and sandstone, exposed in recent falls of the cliffs along the southern shores of the Island, are frequently covered with ripple-marks.

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[*] "Medals of Creation," p. 708.

[†] The method adopted to obtain impressions from engraved monumental brasses, namely, the placing of tough thin paper over the surface of the inscription or effigies, and rubbing it freely with the black composition termed "heel-ball," which adheres to the parts in relief, but leaves the cavities white, will be found convenient for obtaining an accurate plan and outline of the imprints on the sandstone. This process is also applicable to any fossil that has a surface flat and firm enough to bear the friction when covered by the paper. I have often taken in a few minutes imprints of the plates of turtles, scales of fishes, &c., sufficiently distinct to exhibit the general characters of the surface of the specimens.

Every one must have noticed when walking by the side of a river at low water, or on the sands of the seashore, that if the water has been agitated by the wind, the surface of the mud or sand is furrowed more or less deeply by the rippling of the waves; the markings presenting various appearances according to the force and direction of the wind and currents. The undulations on the surface of the sandstone have arisen from similar operations. In many instances the stone is so rough as to be employed in stable-yards, where an uneven surface is required to prevent horses from slipping as they pass over. Sometimes the furrows are deep, denoting that the water was much agitated, and the ripple strong; in other instances the undulations are shallow, and intersected by cross-ripples, indicating a change in the direction of the waves. Some slabs are covered by slightly elevated, broad ridges of sand, made up of gentle risings disposed in a crescent shape; these have been produced by rills flowing into the river, during the recession of the tide. The rippled surfaces often bear traces of the trails of mollusca, and annelides, and in some

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* These were first noticed by Mr. Lyell in 1822, and described in a letter addressed to the author.

† It is singular, that although Professor Playfair mentions the cause of this appearance as undoubted, yet so little attention or credit was given to the statement, that my description of the phenomenon was received with much hesitation.

ents of the claws of crustaceans, of the pectoral
rtain fishes, and of feet of reptiles have been ob-
But I have never detected unequivocal evidence
rks of any kind in the Wealden strata. Impres-
vegetables, several of which appear to have been pro-
by grasses, were abundant on some recently exposed
near Brook Point, on my late visit; the vegetable
r had evidently been changed to carbon, which
a great measure washed away, but enough remained
nt out the origin of the markings. I have observed
appearances on slabs of sandstones and clays lying
embankments of the recently constructed Tonbridge
ilway.

MMARY.—And now, ere we depart from these shores,
nd farewell to scenes so fraught with interest and in-
ction, I would detain the reader a brief space, and
the data are before us, endeavour to interpret the
ure of those physical revolutions of which they afford
such unequivocal evidence. It appears, indeed, scarcely possible for the most incurious observer while sitting on these rocks of petrified trees, and surrounded by fossil bones of enormous reptiles, and heaps of river-shells obtained from the neighbouring cliffs, not to speculate on the causes which have given rise to these extraordinary results. For as a profound thinker has justly remarked, "when any natural phenomena are for the first time observed, a tendency immediately develops itself in the mind to refer them to something previously known, and bring them within the range of acknowledged sequences."†

It was with a view of inducing a train of thought which should lead the intelligent stranger, unfamiliar with the nature of geological evidence, to attempt the interpreta-

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* See Dr. Buckland's "Bridgewater Essay."

† "On the Correlation of Physical Forces," by W. R. Grove, M.A., F.R.S. &c. London, 1846.

tion of the appearances presented to his notice, that this excursion was introduced by some general remarks on the changes effected on the surface of the land, by the agency of streams and rivers.

Let us test the facts before us by the principles enunciated in those remarks. We have here strata of great thickness, made up of laminated detritus, identical in appearance and composition with the consolidated mud-banks of rivers and deltas; we have rafts of drifted pine-trees, and the remains of cycadeous plants, and arborescent ferns —innumerable layers of freshwater shells and crustaceans, with large mussels resembling the unionidæ of the rivers of America—heaps of waterworn bones of colossal oviparous quadrupeds, which comparative anatomy instructs us belong to types of organisation long since extinct—in fine, an accumulation of transported materials teeming with the spoils of some unknown region, associated with fluviatile mollusks and crustaceans, without any intermixture of marine exuviæ. What is the obvious inference—what the unavoidable conclusion at which we must arrive? Unquestionably, that these deposits were the delta of a river, which flowed through a country possessing a fauna and flora of a tropical character, and essentially distinct from any now known to exist.

THE COUNTRY OF THE IGUANODON.—We have here then data from which, by the method of induction previously explained, we may restore, as it were, the region whence the Wealden strata were derived, the animals by which it was inhabited, and the vegetables that clothed its surface. Whether that country was an island or a continent cannot, perhaps, be determined; but that it was diversified by hills and valleys, and irrigated by streams and rivers, and enjoyed a climate of a higher temperature than any part of modern Europe, is most evident. Arborescent ferns, palms, coniferous trees, and cycadeous plants constituted its groves and forests, and delicate ferns the vegetable clothing of its soil; and in its fens and marshes the equiseta, and plants of a like nature, prevailed. Its principal herbivorous quadruped was the enormous lizard, the iguanodon; its carnivora, the megalosaurus and other predaceous reptiles; crocodiles and turtles frequented its rivers, and deposited their eggs on the banks and shoals; and its waters teemed with fishes, mollusca and crustaceans. That the soil was of a sandy nature on the hills and plains, and argillaceous in the lowlands and marshes, may be inferred from the vegetable remains, and the lithological character of the strata in which they are imbedded. Some inferences relating to the prevailing atmospheric condition of the country may also be drawn, from the undulated surfaces of the sandstones, and from the fossil trees. In the former we have proof, that when the land of reptiles existed, the water was rippled by the breezes, which then, as now, varied in intensity and direction in a brief space of time; by the latter, that in certain situations the wind blew from a particular quarter for a great part of the year, and that the mean annual temperature was as variable as in modern times. From what has been advanced, it must not, however, be supposed, that the country of the iguanodon occupied the site of the south-east of England; and that the animals and terrestrial plants of the Wealden lived and died near the spot where their relics are entombed. For with the exception of the shells and crustaceans, which probably inhabited the delta, all the fossil remains bear marks of having been transported from a great distance. But though three-fourths of the bones we discover have been broken and rolled—the teeth detached from their sockets,—the vertebræ and bones of the extremities, with but very few exceptions, disjointed, and scattered here and there—the stems and branches of the trees torn to pieces, and deprived of their foliage,—there is no intermixture of sea-shells, nor of beach or shingle; these remains have been subjected to abrasion from river currents, but not to attrition from the waves of the ocean. The gigantic limbs of the large reptiles could not have been dissevered from their sockets without great violence, except by the decomposition of their tendons from long maceration in water; and if the latter had been the sole cause, we should not find the bones broken and separated, but lying more or less in juxtaposition, like the skeletons of the plesiosauri in the lias. The condition in which these fossils occur proves that they were floated down the river with the rafts of trees, and other spoils of the land, till, arrested in their progress, they sank down, and became imbedded. The phenomena here contemplated cannot, I conceive, be satisfactorily explained upon any other grounds; and the source of the mighty stream which flowed through the country of the iguanodon, must therefore, like that of the Mississippi, have been hundreds, perhaps thousands, of miles distant, from the delta accumulated in the course of ages at its mouth.

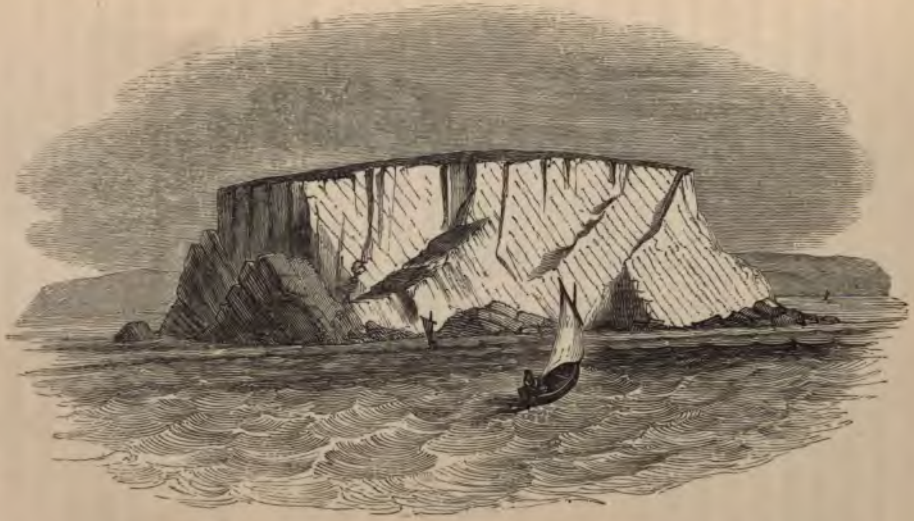
VOYAGE ROUND THE ISLE OF WIGHT.—As during the summer months, excursions round the Island are almost daily made by the steamers, an opportunity is afforded of obtaining a general view of the geology of the coast in the course of a few hours. To a person acquainted with the physical structure of the country, such a voyage is alike agreeable and instructive, and the reader will find a day well spent in taking a rapid survey of the most important geological sections which the coast scenery exhibits. The steamers leave Cowes or Ryde, and take an easterly or westerly course, according to the state of the tide. In the following brief notice, the localities most worthy of remark, in a geological point of view, are described in the order they will appear, if the former route be pursued.

Proceeding from Ryde to the eastward, we coast along [illegible] of the Island, which is almost every- [illegible] to the water's edge; a la- [illegible] at the [illegible] in geological [illegible]. S. [illegible] of Culver, [illegible], and [illegible]. Doubling the eastern [illegible] Bembridge Foreland appears, [illegible] chalk cliffs that terminate at [illegible]. We come in sight of Brading Haven; the [illegible] in a group of [illegible] which form the western [illegible]. The upper horizontal freshwater [illegible] of Whitecliff Bay (see [illegible] obtained of [illegible] by the magnificent chalk cliffs [illegible].

[illegible] of Whitecliff Bay, the vertical [illegible] chalk strata, which forms [illegible] of the Island, is finely displayed. [illegible] varying from 50° to [illegible] marked by the layers [illegible] distinguishable a quarter of a [illegible] which the reader will [illegible] of Bembridge Downs [illegible] between 300 and 400 feet high, [illegible] mile in breadth. When off the [illegible] geological view is obtained; [illegible] vertical chalk, bounded on [illegible] strata of Whitecliff, and on [illegible] of Redcliff.

[illegible] we enter Sandown Bay, [illegible] the lower chalk, firestone, [illegible] in succession, like sloping [illegible] green, blue, and deep red; the [illegible] sands of the lower group.

Pl. XV.



CULVER CHALK CLIFFS; FROM THE SEA.

Sandown Fort is now visible, and marks the low tract consisting of the Weald clay (p. 95). The new church and little town of Sandown are seen on the brow of the sand cliffs which form the western side of the bay, and extend toward Shanklin, retaining the same dark red ferruginous colour as those at Redcliff. The eastern termination of the southern range of chalk, forming the lofty downs above Shanklin, next appears, and seaward, the high but subordinate cliff of greensand at Dunnose Point. The dip of the strata in the cliffs on each side of Sandown Bay, and the anticlinal axis formed by the elevation of the Wealden, may be distinguished by means of a good telescope.

Off Dunnose, we lose sight of the inner range of chalk downs, and gain the region of the Undercliff, which from the sea presents, in the foreground, a line of fallen masses of rock and strata scattered along the sea-shore; and above, a verdant terrace covered with trees and shrubs, with here and there houses peering out from amid the foliage—the barrier of firestone capped with chalk, surmounting the terrace on the north, and bounding the view for a distance of six miles (see p. 184). The ledges of cherty firestone projecting like lines of masonry along the face of this inland cliff, may be distinguished, if the steamer keeps within the usual distance of the shore.

Nearing Blackgang, St. Catherine's appears towering above the western termination of the Undercliff. The Sandrock hotel is seen standing on a ledge high up the precipitous escarpment of the greensand, which here forms the sea-cliff (see p. 173), near the foot of the inland cliff of firestone; the latter rises to within 200 feet of the summit, which is nearly 800 feet above the level of the sea. The ruins of the tower of St. Catherine surmount the whole. The white chalk is seen forming the top of the downs, and appearing from the sea as an inconsiderable layer, immediately over Blackgang.

From Blackgang to Atherfield the cliffs are entirely [illegible], and the general direction of the [illegible] may be easily traced. (See figs. 17, [illegible]) The clays and sands along this part of the coast [illegible] appearance. The lower strata are [illegible] almost black, but the uppermost [illegible] colour; and wherever springs [illegible] clay partings, the cliffs are stained [illegible] of ochreous yellow. This appearance [illegible] by Sir Henry Englefield, to the [illegible] percolates from the surface of the [illegible] strata, and issues out on the face of the [illegible] of the sands and clays is the result of [illegible] of the sulphuret into peroxide of iron. This change is often accompanied by the formation of crystals of sulphate of lime or selenite.* The abundance of nodules of pyrites in these clay cliffs, as well as in those of the Wealden, is so great, that considerable quantities of this mineral are collected on the shore by the cottagers, for sale to the copperas manufacturers.

Approaching Atherfield, the undulated outline of the distant horizon on the north, denotes the re-appearance of the central range of chalk downs, which we lost sight of behind Dunnose Point, and is here seen extending in a south-westerly direction towards the southern shore. The station-house on Atherfield Point marks the locality where the junction takes place between the Wealden and the greensand (p. 162).

The next interesting geological features of this coast, are the cliffs at Brook Point, but the steamers pass at so great a distance from the shore, that the general bearing of the strata only can be distinguished. In the long sweep exposed in these bays (p. 153), the greatly elongated arch, formed by the anticlinal axis of the Wealden (p. 156), may be distinctly made out in a clear state of the atmosphere. Shalcomb Down (p. 160) now forms the inland distance on the north; and as we near Compton Bay, the middle chalk range is seen extending to the shore, and the sea washes the base of the magnificent line of chalk hills from Afton Down to the Needles.

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* A similar result has taken place in some of the railway clay embankments, and been productive of considerable injury to the

The position of the greensand, galt, and firestone, beneath the white chalk, in the cliffs west of Compton Chine, may be distinguished from a distance, owing to the contrast of colour presented by the upper and lower groups; as in Redcliff in Sandown Bay. Freshwater Bay (p. 142) is now gained, and the cliffs of the Mainbench, and of Scratchell's Bay, and the Needles, stand forth in all their sublimity. (See p. 144.) There is one point in Scratchell's Bay in which a magical effect is produced, by the sudden appearance of the richly coloured cliffs in Alum Bay, between the pure white pinnacles of chalk.

As we sail round the Needles, the distant Isle of Portland is seen on the western horizon, and on the north are the shores of Hampshire (p. 119). The vertical strata of Alum Bay (p. 107), and the freshwater series at Headon Hill (p. 111), are now on our right; and we perceive that the structure of this north-western extremity of the island is the counterpart of the north-eastern promontory at Culver Cliff and Whitecliff Bay, which we sailed by in the earlier part of our voyage. Colwell and Thorness Bays are next passed, and we land at Yarmouth to prepare for our excursion to the Dorsetshire coast.

Purbeck may be included in our geological excursions with but little inconvenience. This short voyage is very delightful in fine weather, for with a telescope the principal lines of strata may be traced along the distant coasts, and a comprehensive view obtained of the relations, and original continuity, of the now dissevered masses which form the dry land.

In sailing from Yarmouth towards the Isle of Purbeck, our course, after passing by the Needles, is to the west, and the chalk cliffs of Dorsetshire soon become distinctly visible; and we at once perceive, that if the vertical chalk range we are leaving behind were prolonged in a direct line to the west, it would unite with that towards which we are steering our little bark. Mr. Webster has graphically described the most striking features of the varied landscapes which successively appear in this voyage: "The Island we had just left assumed a very interesting appearance. The gradual rise of the northern side above the sea—the coloured strata of Alum Bay—those singular masses of rock the Needles—with the majestic chalk cliffs behind them of the most dazzling whiteness—and the precipitous face of the southern side of the downs above Freshwater—composed altogether a picture of the most romantic character. On the north lay the coast of Hampshire (see p. 119), consisting of tertiary clay cliffs, above which were seen the town of Christchurch, and several lesser places. As we approached the Dorsetshire side, I perceived that the chalk cliffs were of great height, forming the eastern end of the promontory called Handfast Point; on the north side of which lay Studland Bay, and on the south Swanage Bay. In these cliffs, which present a vertical section of the Isle of Purbeck from north to south, were seen, while we were yet some miles distant, several very large caverns; and towards the north end four or five detached masses of rock rising out of the sea; these were evidently isolated portions

There is a seam of black earth at the distance of five feet, and another two feet lower, beneath the dirt-bed, indicating two short intervals during which vegetable matter had begun to accumulate on the surface of the uppermost beds of Portland stone, when they were first emerging above the level of the sea. In these layers Dr. Fitton observed remains of cycadeous plants.*

The dirt-bed extends through the north of Portland, and appears, as we have seen, on the coast of the peninsula of Purbeck. It has been discovered by Dr. Buckland near Thame, in Oxfordshire, and by Dr. Fitton, in the Vale of Wardour. It also occurs at Swindon, Wilts, where fossil coniferous wood abounds, and some specimens of cycadeæ have been obtained; and between Stone and Hartwell, where it is covered by cream-coloured freshwater limestone, resembling the Cap of Portland, in which wings of insects, and leaflets of the Wealden ferns, have been discovered by the Rev. P. B. Brodie,† and my friend, the Rev. J. B. Reade, Vicar of Stone. In the tertiary freshwater beds at Binstead (see p. 74), there is a stratum of bituminous earthy loam, so like the dirt-bed, that it seems probable it may have had a similar origin, and be the remains of a layer of vegetable mould.

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* See "Wonders of Geology," vol. i. p. 362. For a detailed account of the Portland quarries, and the phenomena concisely described in the text, consult Dr. Fitton's "Memoir;" and Dr. Buckland and Sir H. De la Beche on the Geology of Weymouth, "Geol. Trans." vol. iv. second series.

† See the highly interesting work of Mr. Brodie, entitled, "A History of the Fossil Insects in the Secondary Rocks of England," 1 vol. 8vo., with 10 plates, published by John Van Voorst, 1845. Mr. Brodie has discovered numerous remains of small insects, belonging to forty-eight families and genera, in the Wealden strata of Wilts and Bucks. I have not been so fortunate as to detect any vestiges of Insects in the Wealden of the Isle of Wight and Sussex; but I have two or three wings of small beetles, from Kent, and of neuropterous insects from near Stone, in Buckinghamshire.

ORGANIC REMAINS.—The common species of marine shells, already mentioned as characteristic of the strata below the Purbeck, occur more or less abundantly in the several localities previously mentioned. In the Portland stone, one species of ammonite, of a very large size, hence named *Ammonites giganteus*, is often met with, and good specimens may be procured of the quarrymen. The fossil wood is to be found in most of the stone quarries, and the cycadeous plants, called *Mantelliæ*, may be purchased of the workmen, to whom they are known as "Crows' nests."*

I am indebted to Mr. Damon, of Weymouth,† for the following notice of localities, which may afford useful hints to visitors:—

Ringstead Cliff.—From the Kimmeridge clay, Mr. Damon has obtained specimens of *Pholadomya, Terebratula, Trigonia, Modiola, Ostrea deltoidea, Mya, Pleurotomaria, Phasianella, Ammonites triplex, A. Gowerianus,* &c.

Whitenore.—In the chalk marl, near the base of the cliff, after recent falls, may be collected specimens of *Ammonites, Turrilites, Scaphites, Baculites, Terebratula, Pleurotomaria, Natica, Buccinum,* and several kinds of *Echinites.* The white chalk is not rich in organic remains.

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* At the little village of Chesilton, which is inhabited by some of the quarrymen, I have always been able to purchase specimens. Should the visitor wish to obtain a considerable length of the stem of a tree, with branches attached, it may be well to caution him to beware of imposition. A specimen, sent to me as an entire trunk, was made up of disconnected portions of stems and branches, belonging to several trees, ingeniously fitted and cemented together.

† A fine collection of recent, as well as fossil shells, properly named, may be purchased at Mr. Damon's establishment at Weymouth; also most of the rare species of fossils from the neighbourhood.

In London, fossils from the localities mentioned in the text, properly named, as well as specimens of other British fossils, &c., may be obtained, at moderate prices, of Mr. Henry Stutchbury, 61, Great Russell Street, opposite the British Museum, and of Mr. Tennant, 149, Strand.

At Osmington, two miles west of Whitenore, the limestone rests on Kimmeridge clay, and contains *Exogyra conica*, *Pecten quinquecostatus*, *Cucullæa*, *Serpulæ*, Sharks' teeth, &c. The Kimmeridge clay yields beautiful *Trigoniæ*, *Ostrea deltoidea*, &c.

On the shore opposite Weymouth, between Redcliff and Osmington, the Oxford oolite abounds in shells belonging to upwards of twenty genera.

On the south side of Weymouth, a quarter of a mile east from Sandfoot Castle, the Coral-rag is full of shells and corals. A fine spiral univalve, the *Nerinea Goodhallii* ("Geol. Trans." vol. iv. pl. xxxiii. fig. 12), is found here.

Near Black-rock, half a mile from Weymouth, the Oxford clay abounds in fossils, which can, however, only be procured by digging through a bed of alluvial soil, two feet thick.

The upper bed of Portland oolite, called the "Roach," is a congeries of casts of *Trigoniæ*, *Pernæ*, *Terebræ*, *Ammonites*, *Lucinæ*, &c. Scales and teeth of a species of *Lepidotus* are sometimes found in the Portland stone.

Magnificent *Septaria*, veined with calcareous spar, are found in the Oxford clay, and are cut and polished for tables, slabs, &c.[1]

With this brief account of the Isle of Portland and its petrified forest, these Excursions must terminate. To the geologist, this unpretending volume will, I fear, present but little of novelty or interest, and probably be useful only as a guide to the most important localities; but to the general reader, who may be induced to visit and explore the "beautiful Island," and the picturesque scenes described in the preceding pages, I would fain hope that it may prove a source of pleasure and instruction, by opening to his mind new and inexhaustible fields of inquiry, replete with objects of surpassing interest, and which the uninformed and incurious tourist would pass by unnoticed or disregarded.

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[1] A fine collection may be seen at the establishment of Mr. [illegible] Statuary, on the South Parade, Weymouth.

RETROSPECT.

IN attempting to interpret the natural records of the earth's physical history, the geologist is often in the condition of the antiquary who endeavours to decipher an ancient manuscript, in which the original characters are obscured and partially obliterated by later superscriptions. It is, indeed, frequently difficult, and sometimes impossible, to determine the synchronism of those geological changes, of which the only indications are insulated and but obscurely related phenomena. Bearing in mind the caution of a distinguished philosopher,* "that the language of theory can never fall from our lips with any grace or fitness, unless it appear as the simple enunciation of those general facts with which by observation alone we have become acquainted," we will take a retrospective view of what has been advanced, and endeavour to deduce therefrom some general results as to the nature of those physical mutations, of which we have obtained such unequivocal proofs. Fortunately, the evidence of the important changes which the organic and inorganic kingdoms of nature have undergone in this part of the globe, during the vast periods embraced by our researches, is so conclusive, that the attentive reader will perceive the following inferences, startling as they may appear, naturally result from the facts that have been submitted to his observation.

I. THE OOLITIC EPOCH.—The most ancient deposits comprehended in our Excursions, are the uppermost beds, of an oceanic formation of great extent—the *oolite*—which is characterised by numerous peculiar species and genera of marine reptiles, fishes, mollusks, radiaria, corals, sia

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* Professor Sedgwick.

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II. THE CRETACEOUS EPOCH.—The commencement is era was marked by the subsidence of the entire area occupied by the greensand formation, to a depth suffi-t to admit of the accumulation of the deep sea deposits, which the greater part of the cretaceous beds of England, a of the adjacent portion of the European Continent, nsists. The Wealden sediments were submerged to a great epth, and upon them were deposited sands, and argillaceous ud, and calcareous detritus, teeming with marine exuviæ.* But the ocean of the chalk extended far beyond the limits of the Wealden; it buried beneath its waters a considerable portion of modern Europe, and its waves reached the New World, and covered part of the continent of North America. This ocean swarmed with numerous forms of marine organisms, belonging in a great measure to species and genera unknown in the earlier and in the later geological epochs. The interspersions of freshwater deposits containing terrestrial exuviæ, though inconsiderable, prove that although the delta of the country of the iguanodon was submerged in the abyss of the ocean, a group of islands, or a continent, inhabited by that colossal reptile and its contemporaries, and covered with pine-forests, cycadeæ, and ferns, flourished up to a late period of the cretaceous epoch.†

IV. THE TERTIARY EPOCH.—The bed of the chalk ocean was broken up, and considerable areas were elevated above the sea, and covered with vegetation, and tenanted by pachydermata and other mammalia; the dry land of Europe during this period was less extensive than at the present time.

In the basins and depressions formed by the submerged portions of the cretaceous strata, new sediments began to take place; the sea which deposited them teeming with marine animals, distinct from those of the pre-existing ocean. Local intrusions of freshwater deposits, abounding in the spoils of the land and its inhabitants, denote the existence of islands or continents, tenanted by mammalia allied to the tapir, elephant, rhinoceros, horse, deer, &c.;* and the vegetable remains, consisting of palms and dicotyledonous trees, indicate an approach to the flora of the warm regions of the south of Europe. A few reptiles, principally of the alligator and crocodilian types, and lizards of small size, appear as the representatives of the swarms of colossal oviparous quadrupeds of the previous epochs.

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* *Evidence:* Greensand strata at Atherfield, &c. See p. 163.

† *Evidence:* The Iguanodon, and freshwater turtles, pine-trees and cycadeæ of the greensand of Maidstone; the ferns of the greensand of the Isle of Wight, p. 167; the Clathraria Lyellii of the chalk-marl at Bonchurch, p. 179.

V. THE PRE-HISTORIC EPOCH.—From the most recent tertiary deposits, to those in which occur the remains of animals which seem to have always been contemporary with the human race, the transition is imperceptible. But elevatory movements, and subsidences, more or less general, appear to have continually taken place, by which the relative position of the land and sea was subjected to repeated oscillation. During this period, large pachyderms, as the mammoth, mastodon, hippopotamus, rhinoceros, &c.—several species of horse—gigantic elks and deer—and many carnivora, as the lion, tiger, bear, hyena, &c.—inhabited the European continent and islands. While this fauna prevailed, a succession of terrestrial disturbances occurred, by which the physical configuration of the land was materially changed. England and its islands were separated from the continent; and to this epoch is probably referable the formation of the lines of elevation that traverse the districts over which our observations have extended.

LASTLY.—Man took possession of the land, and such of the large mammalia as had survived the preceding geological revolutions were either exterminated by his agency, or reduced to a domesticated state. Subsequently to the occupation of these islands by the aboriginal tribes, the country has undergone no important physical mutations. The usual effects of the atmosphere, the wasting of the shores by the encroachments of the sea, the erosion of the land by streams and rivers, the silting up of valleys, and the formation of deltas, are apparently the only terrestrial changes to which England and its islands have been subjected during the historic ages.

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* *Evidence:* See p. 83, and p. 123.

Corollary.—From this examination of the geological phenomena of the south-east of England, we learn that at a period incalculably remote, there existed in the northern hemisphere an extensive island or continent, possessing a climate of such a temperature, that its surface was covered with arborescent ferns, palms, cycadeæ, and other coniferæ; and the ocean that watered its shores, was inhabited by turtles, and marine lizards of extinct genera. This country suffered a partial subsidence, which was effected so tranquilly, that many of the trees retained their erect position, and the cycadeous plants, and a considerable layer of the vegetable mould in which they grew, remained undisturbed. In this state an inundation of freshwater covered the country and its forests, and deposited upon the soil and around the trees a calcareous mud, which was gradually consolidated into limestone; thermal streams, holding flint in solution, percolated the mass, and silicified the submerged trees and plants.

A further subsidence took place, floods of freshwater overwhelmed the petrified forest, and heaped upon it accumulations of detritus, which streams and rivers had transported from the land. The country traversed by the rivers, like that of the submerged forest, enjoyed a tropical climate, and was clothed with palms, arborescent ferns, and cycadeæ; it was tenanted by gigantic herbivorous and carnivorous reptiles, and its waters abounded in turtles, and various kinds of fishes and mollusca. The bones of the reptiles, the teeth and scales of the fishes, the shells of

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